# GRINDON'S PATHWAY TO BOTANY

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AN INTRODUCTION TO

*THE CHIEF PARTICULARS IN THE STRUCTURE OF FLOWERING-PLANTS, AND TO THE PRINCIPLES OF CLASSIFICATION.*

BY

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# PREFACE.

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In 1858 I published the "Manchester Flora," with an Introduction to Botany, adapted to the requirements of the student of our native plants.

A few years afterwards I published my "British and Garden Botany," prefixing the Introduction to the "Flora," very much enlarged.

My pupils and others having found this introduction useful, especially in the separate form, I am induced to again reprint it, with considerable additions and improvements.

It makes not the slightest pretension to be an elaborate scientific treatise: it is simply what the title-page calls it—a pathway to more comprehensive volumes.

LEO H. GRINDON.

Manchester,
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# THE PATHWAY TO BOTANY.

BOTANY is the science which considers the nature of Plants,—how they are constructed, what they are composed of, the circumstances of their life and growth, what they are good for, the countries and places they inhabit, their various and charming beauty, along with many other curious and interesting facts, such as render the study of it exceedingly pleasant and instructive, both to young people and old, at all seasons of the year, and wherever we may go.

There are thousands of different kinds of plants. Some grow upon land, others in the water; and of these latter not a few belong to the sea. Many lift their heads high into the air, and throw out beautiful and spreading branches, so as to form trees, which in many cases, when autumn arrives, are loaded with fruit; other kinds are so small and delicate that, in order to see them plainly, we must use a microscope. Between these two extremes there are multitudes of intermediate size, comprising garden flowers, wild-flowers, shrubs, vegetables fit to eat, weeds, moss, and whatever else forms part of the green mantle of the earth. All alike receive the

botanist's attention, and reward him with something useful and satisfactory to know.

The individuals constituting this vast assemblage have, in every case, their peculiar features. Just as the elephant, the rabbit, and the glossy rook are distinguished among animals by their peculiar shape, habits, and colour, so are plants distinguishable from one another by the variety in their leaves, flowers, stems, roots, and seeds. Every one knows how different a camellia is from a daisy, and a sprig of parsley from a red-berried bough of Christmas holly; every one is familiar with the grass of the green fields, so soft to the foot, so cheerful and refreshing to the eye, and sees for himself, without any need of a teacher, how different it is, both in make and stature, from oaks and poplars. What all people thus do partially and vaguely, the botanist does minutely and completely. He investigates the precise nature of the differences between plant and plant, and finding these out, is enabled to discriminate the several kinds with accuracy, then to name and classify them, and to ascertain how many sorts there really are. For although, when we look at plants in the mass, they seem so varied as literally to place it

> "—— Beyond the power
> Of botanist to number up their tribes,"

this is not the actual case. It is known to within

a dozen how many kinds of wild-flowers grow in England, how many in France, how many in Italy, how many in every country that has been diligently and skilfully explored; and in course of time the whole vegetable offspring of our planet will no doubt be reckoned up, and an account of it be printed. The work is already half accomplished.

To learn how to distinguish plants, and to identify those we have seen before, and to qualify ourselves to give the reasons how and why we know them again, and are sure about them, is the first thing, accordingly, that we have to do when we would become botanists. It is not enough to remember a plant by its general aspect, or to say of a lily, for instance, that it is white, and smells sweet. A hundred other flowers, which are not lilies, are white and fragrant, so that the description goes for nothing unless we can follow it up with an intelligible account of the shape and structure of the plant, which will not only be correct in regard to the lily, and apply to nothing else, but convey a fair notion of the lily to a person who has never seen one. This is no difficult matter, every plant in the world being stamped, as already said, with peculiarities which, if they do not render it unique, serve at least to give it features and physiognomy. All the parts of plants supply these signs and tokens, though some more immediately than others. The Flower and Fruit, as the loveliest and noblest,

and the parts to which all the aims and energies of the plant are directed from the first moment, naturally stand foremost. Next in importance come the Leaves, then the Stem and inferior members, the value of each part, as a witness to identity, gradually diminishing in the degree that it is coarser and less perishable. Everywhere in nature, that which most powerfully characterises a thing is its most fragile part, and however frequently renewed, like the sparkle of a diamond, is the quickest to come and go.

But it seldom happens that any one part by itself is absolutely enough whereby to recognise a plant. A single circumstance suffices in the case of the Sundew, which is told at a glance by the curious crimson hairs that sprout like eyelashes from the edges of its leaves (Fig. 137); and again, in the case of the Ice-plant, which is sprinkled over its whole surface with glittering water-gems. But for the identification of plants in general, we need the concurrent testimony of many parts. The reason of this is the close resemblance which subsists among trees and flowers, the likenesses they bear to one another being, if possible, even more wonderful than their differences. Just as there are classes and tribes of animals, the members of which correspond more or less obviously, as the cat with the tiger, and the wolf with the fox, so are there tribes and families among plants. The Ferns constitute

one family, the Grasses another, the Palm-trees a third, the Balsam-trees a fourth. The distinguishing marks of a plant are thus of two sorts:—First, those which it possesses in common with many others; secondly, the private and personal ones which pertain exclusively to itself. Both must be attended to; but with a little practice we get accustomed to the former kind, and are left at leisure to devote ourselves entirely to the private and personal marks. Half our native plants belong to no more than ten families, three hundred species to ten others, and the bulk of the remainder happen to be so singulary formed, that they stand as distinct and individualised as islands out in the sea. No one having once examined it, can forget the Arum of the spring hedgebank, with that curious sheath, and crimson or buff-coloured club, which has obtained for the plant the *alias* of "Lords-and-ladies"; nor can any one ever forget the Trulove, with its four large oval leaves, and solitary green blossom of perfect symmetry, followed, in due time, by a purple berry.

Attention to families immensely facilitates the learning of species; just as from careful observation of species in the first place, we discover what is the nature of a family. When, for example, by studying the twenty kinds of common hayfield grass, we have got the Grass-family pretty distinctly before the mind, we can walk at our ease among their beautiful

and modest cousins in the woods, and none shall withhold their name and nature from our curiosity.

The great charm of learning the kinds or species of plants, consists in the pleasant intimacy it brings us into with Nature. Quick to identify its manifold lovely objects, we no longer look at it as at the faces of the people in a strange town, but with the agreeable feeling of being at home, and among companions. The great value of learning the families, on the other hand, or rather the fine correlative advantage, each pursuit bearing upon and augmenting the success of its fellow, lies in the illustration which plants cast upon one another; for agreement in structure implies, to a considerable extent, similarity also in properties and uses. When we find a plant bearing a flower composed of four distinct petals, arranged in the form of a cross moline, and having those other simple characters which constitute it one of the Crucifers, we may presume that that plant is wholesome,—not necessarily palatable, but devoid of anything deleterious. The turnip, the cauliflower, water-cresses, and many other esteemed vegetables, belong to this family, any member of which, however great a stranger, or found for the first time by an emigrant in some distant country, may be eaten with confidence, provided it be juicy and agreeable to the taste. With the Nightshade-family it is the reverse. Here we must expect venom, cruelty, and even death. Every

one has heard of the Deadly-nightshade, that malignant plant which hangs out its tempting berries to the imminent peril of those who eat. It is proper to remark, however, that families which contain poisonous species, are not upon that account noxious in every case; the rest of the family may be harmless, and here and there even wholesome. Making all allowance for this, a great point is still gained in knowing where we are safe, and where we are probably in danger. Similarly, and further illustrating how largely structure and particular properties go together, the Poppy-family is narcotic, the Buttercup-family acrid, the Myrtle-family aromatic, the Gentian-family bitter, and, in medicine, usefully tonic. Other families are remarkable for the strong fibres of their stalks, their mucilage, their sourness, their colouring matters, and so on, though always with the limitation mentioned in the case of the poisonous plants; and many and most valuable have been the discoveries made among their different species by the light of the great principle these facts exemplify. This is not the only reward. A great and noble aim always wins variety of recompense. In studying the families of plants, our eyes are opened not only to matters of bodily interest, or such as have relation to food, clothing, and medicine, but to that grand and wonderful concord and consanguinity of things which far more than the bare fact of their existence

declares so plainly the wisdom and love of Him who made them. The beginning of our contemplation of Nature must always and necessarily be devoted to *differences;* as we ascend, we find that the highest and most beautiful part of knowledge is that which traces *resemblances;* and that resemblances resolve at last into unity, as the scattered trees of the plain, surveyed from the mountain-top, become a forest, and fill the eye as a single leaf.

Let us now proceed to consider the parts of which plants are composed, and by the peculiarities of which they are distinguished and associated. It must be premised that plants are either "perfect" or "imperfect," or, to speak more correctly, "complex" and "simple," since nothing in nature is absolutely imperfect, but everything modelled after a type that is perfect in its own way. The difference in its objects as regards structure, is merely that of a greater or less complexity, and greater or less diversity of constituent parts. "Perfect" plants are those in which all or nearly all the parts ever entering into the fabric of trees and flowers, are present in high and beautiful development, a special organ being appropriated to every different function. The chief criterion is the presence of a Blossom, formed in the way presently to be described; in practice, indeed, this is the only infallible test, for occasionally, even where blossoms

are present, the other portions of the structure are of exceedingly low development, whereas none of the plants comprised in the great division called "Imperfect" ever produce blossoms such as we refer to. "Perfect" plants form the great mass of the *conspicuous* vegetation of our earth. With a few exceptions, the members of the other great class are inconspicuous, people in general scarcely noticing them. They are replete with wonderful beauty nevertheless, delighting the true lover of nature not more with their delicate and unexpected forms, than with the simplicity of their organisation, competent as it is to the performance of every one of the offices which in perfect plants devolve on as many servitors. We shall take the "perfect" division first, as naturally most attractive to taste and fancy, and opening the pleasantest avenues to botanical knowledge.

However large and complex a plant may be, and whether tree or herb, its parts are all resolvable into these five:—

THE ROOT,
THE STEM,
THE LEAVES,
THE FLOWER,
THE FRUIT.

Some of these parts often bear curious appendages, such as hairs, thorns, stings, prickles, and tendrils; but there is never any other distinct

member, and the tallest tree is only a repetition of them over and over again. Not that the whole five are always present, even in perfect plants. The mistletoe has no true root, the crocus no true stem, the cactus no true leaves. But there are few plants in which we may not find the greater portion, under some shape or other, when we have learned what strange disguises they are prone to assume. For if Nature seem playful in the myriad shapes of her rosy sea-shells, and in the plumage of her innumerable bright birds, no less sportively does she behave herself in the fashioning of her plants and flowers.

A word, before we proceed further, as to the Language of Botany. In order that everything shall be clear and precise, it is absolutely necessary, in dealing with the facts of our pleasing science, that special terms shall be employed. Botanical words and names are often thought particularly hard and numerous. They are no more so than the words and names employed in chemistry, geology, or any other branch of knowledge, or than those of the ordinary geography of our every-day life, which in its Chimborazos, and Guadalquivers, and Titicacas, and Alleghanies, and Orinocos, and Spitzbergens, is quite a match for the vocabulary of the hardest Botany that was ever invented. Depend upon it, things are "hard" only when we do not care about them. Taking interest in a subject, no matter what, soon renders it easy. These very

words, so much dreaded, are but like the names of new acquaintances, strange when we first hear them, but which, in a week or two, become as familiar as those of our best-known friends. Technical terms cannot be dispensed with, if we would master a subject. Every branch of knowledge has a language of its own, and it is quite a mistake to suppose that Botany can be made an exception. The simple fact of its variety and beauty implies a vocabulary to match, just as a large and populous country implies in its towns and cities a map full of names of places. To attempt to dispense with technical terms, would be as hindering to the real progress of the student, as uncomplimentary to his intelligence. Ordinarily, too, these terms are so exact, so expressive, so indifferently translateable into words of colloquial speech, that it would be a far greater pity to attempt to leave them out than it is troublesome for the young Botanist to make them his own. Moreover, they have not to be learned all at once, but one by one, as they are wanted, and become interesting; and when brought together in pages like the present, it is not so much with the idea of their being committed to memory in a lump, like a lesson in an old-fashioned school, as to be explained systematically, and to be ready for reference.

## THE ROOT.

The Root is that strong, underground part of the plant which holds it firmly in its place,—as anchors hold ships,—and also sucks up water, and transmits it to the stem above. Generally speaking, it consists of two portions, one stout and thick, and more or less branched, called the "caudex;" and issuing from this, a vast quantity of slender fibres, resembling threads. In small plants the caudex varies from the size of a quill to that of a man's arm, and is dry and woody, or soft and juicy, according to the use it is designed for. Sometimes there is no proper caudex, and the root is fibrous throughout. The caudex of the roots of trees often grows to be nearly as large and massive as the boughs, but in either case the fibres or rootlets are slender and threadlike. The extremity of every fibre is soft and spongy. At the very tip the fibre is covered by a closely-fitting sheath, which is being constantly renewed upon its inner surface, so that as the outer or older layers become exhausted or worn away, in consequence of the fibre having to force a passage through the soil, fresh ones are constantly being originated within. From the apparent likeness of this little sheath to a sponge, and the function of the root being to absorb moisture, the tips of the fibres long ago received the name of "spongioles." The reason why plants after being shifted from one part

of the garden to another, hang down their leaves, and often die, especially if the transfer be made in warm weather, is that the spongioles get injured, and many of them broken off during the process. When a good ball of earth is preserved about them, the transplantation may be effected without injury, or check to the daily growth. Roots are frequently the receptacles or reservoirs of the plant's secretions. Hence, they are often, internally, of some fine colour. The turnip, for instance, is white; the carrot is yellow or orange, a tint which is possessed also by the roots of many species of dock; while in the beet and the Sanguinaria it is crimson. Hence, again, roots often become valuable for food, or as yielding dyes or medicinal substances. Partly upon the duration of the root, though partly upon other circumstances, to be mentioned presently, depends the length of time that a plant exists. There are three principal descriptions of lease or term of life in plants. Those which live for only a few months, say from spring to autumn, and then die from exhaustion, or are destroyed by the frost, are called "Annuals;" those which live, as regards their roots, for portions of two years, are called "Biennials;" and those which survive for a long series of years, their roots retaining vitality, whether the stems die down in the winter or not, are called "Perennials." The turnip is a biennial; yellow lupines and sweet-peas are only annuals.

Some plants have portions underground which are *not* roots, as tulips, onions, snowdrops, lilies, and even potatoes. These parts will be described after we have treated of Stems, to which class of parts they are properly referable, for in Botany, as in everything else, it is not the place that a thing is in that determines its nature, but what it is composed of, and how it is employed.

## THE STEM.

The Stem is the part of the plant which ordinarily rises into the air, preserving a more or less erect position, generally dividing into branches, and bearing the leaves, the flowers, and the fruit. Whether weak and diminutive, as in the violet, or a tall, stout, and woody pillar, as in the trunk of a tree, it is still called the Stem,—the boughs, the branches, and the twigs being included under the one general name. Many particulars have to be noticed in regard to it, the chief of these being the shape, the kind of surface, the direction which it takes, and the amount of ramification or branching to which it is subject. Very important also is it to ascertain the *internal structure*. But to do this we are by no means obliged to cut down the plant, or even to wound it, since the information, as we shall see presently, is usually supplied by certain facts connected with the leaves and flowers.

1. *The Shape.*—This we find to be very frequently cylindrical, but there are plenty of examples in which the stem is four-cornered or three-cornered. Sometimes it is deeply grooved or furrowed, and in the everlasting pea it is curiously "winged," that is to say, flattened and dilated, so as to possess two thin green borders.

2. *The kind of Surface.*—Very generally the surface is perfectly smooth. When in no way rough or broken, it is said to be "even," and when quite free from any kind of hairiness it is "glabrous." Some plants have their stems, and their leaves also, densely clothed with down, hair, wool, scurf, or some sort of silky or velvety vesture. In the hemlock, the dragon-arum, and several others, it is spotted and blotched with purple. Very often the surface is armed with thorns, as in roses and brambles. (Fig. 59.) When these weapons are superficial, and can be pushed off with the finger, they are considered to be bodies of the nature of hairs, but grown immensely thick and strong. If provided inside with venomous fluid, which causes pain when the finger is pricked by them, they are "stings." Thorns and prickles must be carefully distinguished from "spines," such as we find in the hawthorn, since these are the abortive rudiments of twigs, as proved by their position, and by their often bearing one or two minute leaflets. Unlike thorns and prickles, which also occur upon leaves, spines are confined to

the stem. They are organically connected with it, and can only be removed with the knife.

3. *The Direction.*—Usually, as above said, the principal member of the stem is erect; sometimes remarkably so, as in the trunks of fir-trees and the Lombardy poplar. In small plants, on the other hand, it often lies prostrate upon the ground, and is then called "procumbent." (Fig. 92.) When the stem of such a plant begins with being procumbent, and afterwards erects itself, it is said to be an "ascending" one. The common purple mallow, when well developed, usually has its centre stem erect, while the lateral ones are "ascending." When a procumbent stem takes root at every joint, and the plant sets up outposts, as in the strawberry, it is called a "creeping" one. (Fig. 9.) Should these "creeping" stems be developed, in part, below the surface of the soil, they constitute "suckers," and by means of them the plant may spread itself over an immense extent of ground, as happens with mint and certain kinds of thistles. If it be cut with the spade, almost every portion will grow, just like a slip taken from an aërial branch. The stems of the honeysuckle, the hop, the scarlet-bean, and many others, being too weak to stand upright, and more ambitious than the procumbent kinds, lift themselves towards the sun by twining round their stronger neighbours, or whatever slender column may be nearest, some kinds turning to the right,

and others to the left. (Fig. 42.) The nasturtium, Virginian-creeper, ivy, fumitory, and many other weak-stemmed plants, ascend by curious methods which quite remind us of the contrivances of instinct. The Virginian-creeper, so common against house-fronts, puts out little sprays, every branchlet of which is tipped with a gland that holds with such tenacity to the wall, that, rather than leave go, the spray will break off at the wrist. Ivy, as every one may observe, puts forth innumerable little holdfasts, which perhaps may serve the additional use, though very imperfectly, of roots. (Fig. 51.) All such stems as these are called "climbing," in contradistinction to "twining" ones, which always take a spiral direction. In tropical countries the climbers and twiners are far more numerous than in cold and temperate latitudes, and frequently mount to the tops of the tallest trees, just as in England we see the wild clematis, the woodbine, and the bryony throwing out their graceful trails and festoons along the crests of the hedges, or mantling some old thorn with a luxuriance no longer its own.

4. *The Ramification.*—The rule with plants, excepting in certain families of peculiar structure, is for the stem to divide and subdivide into innumerable boughs, branches, and twigs. Of course it is owing to the varying thickness and solidity of these, and to the various directions which they take, that

we have so rich and wonderful a diversity in the profile, contour, configuration, or physiognomy of plants, especially of large ones, such as shrubs and trees. We need but think of the different outlines of the oak and the elm, of the massive chestnut and the lightly swinging birch, to see at once that their artistic beauty arises mainly from this cause, the foliage being only so much apparel. Identically the same diversities pertain to the stems of low-growing plants, whence arises in great measure the incessant novelty of the flower-border and of the wild hedgerow. When very straggling and irregular, the branching is said to be "diffuse." Sometimes, as in the mistletoe, the stem is repeatedly forked, but in a symmetrical manner: the term applied to this condition is "dichotomous."

But many plants, and even whole families of plants, have stems which never branch at all. These are magnificently illustrated in the palm-trees and in the banana (Fig. 117); also upon a smaller scale in lilies, grasses, reeds, and rushes, and in some of the very extraordinary succulent plants which go by the general name of Cactus. Unbranched stems of this character are denominated "simple" ones; the antithesis of this term, sometimes applied to branching stems, being "compound." We must be careful, however, not to confound simple *stems* with mere *flower-stalks*, such as those of the cowslip and the bluebell. All true stems,

whether simple or branched, either bear leaves or their rudiments, or retain the scars of former leaves, or they have joints at definite intervals. When no such characters are present, we may be sure, accordingly, that we have before us no more than a "peduncle." The wood-anemone stalk, strange to say, is itself not a stem: the three *quasi*-leaves * being organs of another description, as we shall better understand by-and-bye.

We have now to consider those remarkable modifications of the stem which constitute the principal subterranean portion of many plants, and are commonly confounded with the root. The most frequent is that one called the "rhizome," well illustrated in the common iris or fleur-de-lis, also in the aromatic acorus, and in the wood-anemone. It consists of a greatly thickened but usually very short procumbent branch, sent out horizontally from the original centre of growth, almost always keeping below the surface of the soil, despatching true roots from the under-surface, and periodically developing leaves and flowering-shoots from the extremity. The withered relics of these leaves often cover the whole of the older portion of the rhizome, as plainly shown in the arrowroot plant. Ginger is also an example of

* *Quasi* signifies "as if," and when prefixed to a word or name, denotes resemblance without the reality.

a rhizome, which form of stem is indeed more common than often supposed.

Another specially interesting subterranean modification of the stem is that one called the "tuber," the best example of which is the common potato. (Fig. 7.) The potato plant, in addition to the stems which it elevates into the air, sends out many below the surface, much after the manner of the runners of a strawberry, only that they do not extend beyond twelve or eighteen inches. After a while, these underground stems stop growing, but sap, transmitted from the aërial ones, continues to flow into them, and, there being no escape for it, accumulates at the extremity, where it gradually forms the potato, just as a stream of water, suddenly checked by a fallen bank of earth or other obstacle, accumulates behind the barrier, and forms a pond. The real roots of the potato are the brown fibres which hang down from it.

Tubers are occasionally mimicked by greatly enlarged and swollen root-fibres, as in the Œnanthe. Any substantial underground body of the nature of a potato is in fact, conventionally, if not legitimately, called a "tuber." Orchises often possess curious ovoid or palmate tubers, as illustrated in Fig. 8.

Lilies and their allies, including the common onion, usually have their stem developed to so

slight an extent that it constitutes no more than the meniscoid* plate or platform at the base of the congeries of rudimentary and prospective leaves, which in these plants constitutes what is called the "bulb." (Fig. 5.) If the student will carefully cut a lily-bulb, or an onion, from top to bottom, so as to obtain a vertical section, as shown in Fig. 6, this becomes evident; for we then perceive that the great mass of the bulb is a *bud*, and that the stem is represented in the spongy and convex floor, from the underside of which descend the veritable roots. Every one is familiar with the long white roots which go down from a hyacinth-bulb when grown in water in the parlour, and which illustrate, at the same time, what appears to be a universal principle,—viz., that true roots always seek the terrestrial centre of gravity, whereas stems (excepting the subterranean rhizomes, etc., and those which, being slim, are pendulous by nature), are always endeavouring to get nearer to the sun. Because of this, the lilies, the onion, and similar plants, should be classed with the "stemless," or "acaulescent" ones. This latter term is usually restricted, however, to plants in which the stem constitutes a mere crown to a root which is not bulbous, and of which we have

* *Meniscoid*, shaped like an old-fashioned watch-glass, convex above and concave below.

innumerable examples. Take, for instance, the primrose (Fig. 100), the dandelion, and the common plantain. It is also customary to say of these "stemless" plants, that their leaves and flowers are "radical,"—a term intended to denote that they arise from the "radix" or root. While the term "radical" is no doubt a good one, as expressing an *appearance*, it is important, however, to remember, that in reality these leaves and flowers rise from a stem, only so short a one as to seem wanting. A stem of some kind or other invariably intervenes between the root of a plant and the foliage.

Thoroughly to apprehend the nature of "bulbs," it is necessary to fall back upon the principal and most conspicuous office of the stem, which is to produce "buds." If we examine a tree in winter, we find the twigs studded with swollen bodies which, when spring arrives, will enlarge and expand, and gradually give rise to twigs covered with leaves. These "buds," so called, are fashioned much the same as "bulbs," and bulbs are fashioned much the same as buds; and each organism is interpreted by such things as the rosette of the house leek, or even by that of the silver plantain; the former, in particular, is exactly comparable with the "scaly bulb" of some of the lily family. Bulbs, accordingly, are huge underground *buds*, isolated upon the surface of underground

stems that consist of no more than a circular and convex platform.

It is to be observed of bulbs, that they are sometimes as large as a child's head; also, that they are never permanently crowned with green leaves, but are deciduous, and have a period of winter-repose like most of our forest-trees; also, that they are peculiar to the great primary class of plants called "Endogens,"—since the swollen growths at the base of the stem of the *Ranunculus bulbosus* and similar plants are only *quasi*-bulbs; also, that no plants which form bulbs are either annual or biennial.

Ordinarily the "buds" are developed in the "axils" of the leaves; that is to say, in the little cavities or spaces immediately above the inner base of the leaf-stalk. Adjacent to these "axils," there are very frequently found joints or "nodes." In any case, it is found convenient to designate the lengths of stem which intervene between leaf and leaf, by the name of the "internodes" (see Fig. 31); and thus are we brought round again to the true idea of the bulb, which is that of a collection of leaves not separated by internodes. Further, as the buds of trees arise from the axils of the leaves, so do the budlets of bulbs originate in the axils of their leafy layers, as we may see beautifully illustrated in hyacinths.

Another curious modification of the subterranean

stem is seen in the crocus, which well illustrates the "corm" or "cormus;" and another of the internodes of the stem-proper in many of the tropical orchids, which possess ovoid and conical organs called "pseudo-bulbs."

While stems and branches, as described, are occasionally produced below the surface of the ground, it is interesting to observe that roots are sometimes put forth from the aërial parts of the plant. A pretty and familiar example of this occurs in the Selaginellas,—such favourites for fern-cases and indoor ferneries; it is well illustrated also in tropical species of fig, and in many other plants which grow in the damp hot woods of the equatorial zone, and preserve their native habits when cultivated in English conservatories.

The duration of a plant (its being "annual," "biennial," or "perennial") has already been stated to depend partly upon the root. The stem is the other part to be considered; and here it must be observed that numberless plants possess perennial *roots*, but develope new stems fresh and fresh every year, the old ones disappearing in the autumn. Some botanists consider "annuals" to be plants which blossom only *once*, though they may require to be several years old before strong enough to produce flowers, and designate them by the name of "monocarpic." But it is far better to let the term hold its proper etymological and practical meaning.

Whether annual, biennial, or perennial, all plants that die down in autumn, and all that are of a soft and succulent nature, whatever may be their stature, are called "herbaceous"; perennials with woody stems, many of the latter generally rising side by side from the root, are called "shrubs"; tall and woody perennials, with a single upright shaft, producing boughs and branches, are "trees." Conventionally, the name of "tree" is also applied to certain long-enduring or very ligneous varieties of herbaceous plants, as when we speak of tree-carnations, the tree-lupine, and tree-mignonette. Useful adjective terms, indicating a tendency to the shrub-like and to the tree-like character, are "suffrutescent," "suffruticose," and "arborescent"; the two former derived from *frutex*, a shrub, and the latter from *arbor*, a tree.

The *internal structure* of the stem presents itself, in flowering-plants, under two principal modifications. Of course, it can only be learned absolutely by taking sections, both horizontal and vertical, and at various stages of the growth of the plant. But minute observers have ascertained that whenever a plant has its leaves veined in a particular manner, there is a particular structure of the stem to correspond; also that when the *blossom* is fashioned after a given manner, we can tell, pretty certainly what kind of stem produced it; and, lastly, that there is an agreement even between the mode of

the germination of the seed and this wonderful stem-structure! The appearance presented by a horizontal section of each of these two principal varieties of stem is shown in Figs. 1 and 2, the first of which represents the stem of a tree of the "exogenous" class, aged about twenty years, and the other that of an "endogenous" plant. Exogenous stems consist of wood, bark, and a thread of pith in the middle like the marrow in a bone. While young, the resemblance to a bone is very striking; the pith then greatly preponderating, as well shown in a twig cut from an elderberry-tree. Afterwards the proportions change; so that, in aged plants, the pith is reduced, as shown in the figure, to a mere thread. While the twig or stem is very young, the pith is encircled by only a single layer or cylinder of woody matter; but, in the course of every year's growth, a new layer is deposited, externally to the preceding one, so that at last we can pronounce as to the age of the individual part we may have the section of; that is to say, we may tell how many years that particular branch was alive and growing, simply by counting the layers, the cross or horizontal sections of which present the appearance of rings, disposed more or less concentrically around the pith. The reason of the annual rings of wood showing so plainly is, that the wood formed in summer and autumn is more dense than that which is formed in the spring, and supplied with fewer sap-vessels.

Sometimes the rings are quite indistinguishable, especially in woods of very dark or of very light colour, as happens in ebony and in holly; and sometimes the layers are *undulated,* as shown very curiously in the wood of the South American *Cœsalpinias,* imported, on account of its colour, for the dyers. Besides the rings, there are, in exogenous trees, "medullary rays," which present the appearance of lines proceeding from the centre to the circumference. These indicate vertical plates of "cellular tissue." The bark of exogenous plants, when the stems grow to be several years old, as in the case of trees, is likewise deposited in concentric layers, the newest *interior* to the preceding; but exposure to the atmosphere causes the surface-layers to wear away rapidly, so that the bark is not only often fissured and cracked, but constitutes a mere skin when compared with the layers of wood, and, of course, supplies no information as to the age of the plant. Stems so formed internally, whether the plant be large or small, almost invariably possess branches. All our British forest-trees, all hardy exotic trees and out-door fruit-trees, all our shrubs, and the greater portion of our ordinary vegetables, garden-flowers, weeds, etc., exemplify this fact more or less distinctly; the branches of young trees, and of stout herbaceous plants, such as the sunflower being the best for the student's purpose when verifying it for himself.

In the "endogenous" stem (Fig. 2), there is no distinction of wood, bark, and pith. The outermost portion is a simple crust, homogeneous, like the crust of a loaf of bread, with the interior substance, and not separable after the manner of true bark. The appearance of dots produced by taking a horizontal section, comes of the cutting across of the bundles of woody fibres, which are much thicker, and also closer together, near the circumference, diminishing, in both respects, towards the centre.

Ordinarily, this kind of stem is perfectly "simple;" that is to say, destitute of branches. In England it is plentifully represented in the reeds, grasses, lilies, etc., but not in any kind of *tree*. For arborescent examples we must go into our hothouses and conservatories, where the endogenous idea is splendidly set forth in the palms of the tropics. It is singular, however, that in England we have among our wild plants, a couple of the anomalous endogens in which branches are developed, namely, the common evergreen shrub called butchers' broom, and the common culinary asparagus. *Annual* stems, it is proper to add, whether exogenous or endogenous, are very often hollow or "fistular," as well shown in many of the hemlock-family and in grasses.

## THE LEAVES.

No part of the plant, not even the flower, requires more careful consideration than the leaf. The source of a great part of the beauty of the world, as we feel so powerfully when the verdure of spring returns, there is scarcely anything in nature more diversified, or which presents forms of greater symmetry, or of more elegant simplicity.

Nor is there anything in the organization of the plant as an individual, to which we have so frequently to recur, in order to satisfy ourselves as to differences and affinities. First, we consider the *shape* of the leaf; then what kind of margin it possesses; then after what manner the veins are diffused; then what is the disposition of the leaves upon the stem. When these particulars have been noticed, there are others, often of a very curious character.

I. *The Shape.*—Usually, a leaf consists of a stalk or "petiole," and a thin, flat, and expanded portion, termed the "blade" or the "lamina." (Fig. 26.) This "lamina" presents every conceivable variety of outline, the latter extending from the long and slender needle of the pine-tree, up to the broad and angular shield of the rhubarb. Very often we find the lamina deeply gashed or "divided"; and very often again, instead of a solitary blade, we find two, three, five, seven, or sometimes a score, or even

many scores of pieces, usually small, and termed "leaflets" or "bladelets," the petiole itself being then more or less branched or subdivided. Leaves, accordingly, regarded as to their general shapes and composition, are referable to the three following classes :—

1. Simple and undivided.
2. Simple and divided.
3. Compound.

1. *Simple and undivided.*—No figure can be drawn, round, oval, elliptical, square, heartshaped, or triangular, in any variety, that has not already been employed by inventive Nature for the leaves of this first section. To enumerate their figures would require pages, and many of them being very rare, the list would, after all, be only a burden; it is sufficient, accordingly, to specify the most usual ones. The illustrative drawings, let us premise, are not intended to indicate sizes, not even relative sizes, but simply the shapes or outlines. Neither are they in any case theoretically or artistically "touched up," but sketched directly from nature. Omitting the uncommon ones, the following, then, are such as require our first attention.

"Needle-shaped," as in the pine and fir.

"Linear," very narrow, with the margins either parallel, or tapering to the point, as in a blade of grass. (Fig. 47.)

"Lanceolate," or "spear-shaped," long and narrow, and tapering to each extremity. (Fig. 35.)

"Lingulate," or "tongue-shaped," having the margins parallel, but the end rounded. (This description of leaf is usually thick and fleshy.)

"Oval," twice as long as broad, and narrowing to each extremity." (Fig. 13.)

"Ovate," or "egg-shaped," in length and breadth like the former, but narrowing to the upper extremity, like the longitudinal section of an egg. When the base is the narrower end, it is called "inversely egg-shaped," or "obovate." (Fig. 22.)

"Circular," when the length and breadth are about equal.

"Kidney-shaped," or "reniform." (Fig. 14.)

"Heart-shaped," or "cordate." (Figs. 15 and 37.)

"Triangular." (Fig. 57.)

"Hastate," arrow or "spearhead-shaped." (Fig. 19, and 141–143.)

"Oblique," as in the Begonia. (Figs. 43 and 61.)

When any of these figures are drawn out in the middle, so as to be longer than usual, and have their characteristic curves well shown only at the extremities, it is customary to speak of them as "linear-

lanceolate," "narrow-oblong," etc. Better would it be to say "elongate-lanceolate," "elongate-oblong," etc.

2. *Simple and divided.*—The transition to these is very gradual: a "divided" leaf being no more than one in which the spaces between the veins are imperfectly filled up, so that gaps of less or greater magnitude are presented, either throughout the whole area of the blade, or at its base or apex. There is no limit, no absolute place where "undivided" ceases, and "divided" begins, and in many plants we have every stage between the two extremes;—in the common field scabious, for example. Divided leaves fall, however, into two great sections, determined by the primary veins. When there is only *one* leading vein, which proceeds from the petiole to the apex of the lamina, the leaf is constructed upon the "vertebral" type, usually termed "feather-veined"; but when several leading veins shoot out from the petiole, fan-wise, it is "fan-lobed." To the feather-lobed series belong:—

"Pinnatifid." (Fig. 44.)

"Lyrate," or "lyre-shaped," the terminal lobe or division always very large. (Fig. 52.)

"Runcinate," when the segments are pointed, and directed towards the base of the leaf, as in the dandelion. (Fig. 27.)

"Pectinate" or "comb-like," a pinnatifid leaf,

with very narrow, close, and parallel segments, resembling the teeth of a comb.

"Doubly-pinnatifid" and "triply-pinnatifid," when the lobes or segments are themselves cut and divided, as in the tansy leaf.

To the fan-lobed type belong:—

"Fan-lobed," when with five or more great clefts directed towards the leaf-stalk. (Figs. 24 and 41.)

"Fan-lobed and cut," as in the monkshood. (Fig. 40.)

"Palmate," when the clefts extend nearly to the base of the leaf, as in many kinds of passion-flower.

"Ternate," as in the strawberry and the wood-anemone.

The last-named show the first step towards that very remarkable modification of the "simple and divided," which culminates in the leaves of many of the hemlock-family, common parsley for example; for the leaf of this vegetable is a perfectly simple one, but broken up into innumerable lobes or segments. It is not strictly referable either to the feather-lobed or to the fan-lobed type, serving, rather, to connect the two. Such leaves are generally termed, like those of the tansy, "triply-pinnatifid," or "thrice-pinnatifid."

3. *Compound Leaves*, compared with simple-and-divided ones, present the very obvious and exact

distinction of having their leaflets articulated or jointed to the petiole. However minute or numerous may be the subdivisions of such a leaf as that of the hemlock, the elements are all truly confluent with their neighbours, and not the minutest can be detached without tearing. Not so with the compound leaves. In these, every leaflet is articulated to the petiole, or to one of its branches, as decidedly as one's hand is articulated to the arm, and hence, in decay, the compound leaf usually drops to pieces, as every one may notice in the horse-chestnut. Another capital characteristic of compound leaves is, that in the evening the leaflets frequently change their position, assuming those elegant attitudes which are poetically likened to repose and to "sleep;" but of which "divided" leaves are perfectly incapable. The distinctions of compound leaves are much the same as simple-and-divided, viz.:

(*a.*) *The Feather, or Pinnate, type.*

"Binate," when there are only two leaflets. (Fig. 30.)

"Trifoliolate," when there are three. (Fig. 23.)

"Pinnate," when several pairs of leaflets proceed from the petiole, the portion which bears them, receiving the name of "rachis." There may be only two or three pairs of leaflets, or there may be thrice, or four, or even ten times as many: and there may be a terminal one, as in the rose, when the leaf is called

impari-pinnate or "odd-pinnate" (Fig. 32); or the pairs may be complete in themselves, in which case the leaf is called "pari-pinnate," or "even-pinnate." Cassias give good examples of this. Sometimes, as in peas and vetches, several of the upper pairs of leaflets are undeveloped, and in place of them we have nothing but the central veins or midribs of the leaflets, which are then much elongated, and, under the name of "tendrils," serve the purpose of grappling instruments. (Fig. 54.) Tendrils occur also in "binate" leaves.

"Doubly-pinnate," when, instead of single leaflets, there are, as it were, smaller pinnate leaves. Acacias furnish fine examples. (Fig. 33.)

(*b*) *The Fan type.*

"Quinate," when there are five leaflets, all from one point. (Fig. 38.)

"Septate," when there are seven.

"Digitate," when the leaflets are numerous, and usually narrow, resembling fingers, as in the lupine. (Fig. 50.)

II. Next as to the *margin* of the leaf. The differences found in the margins of simple leaves occur also in the leaflets of compound ones, though not so markedly.

They are designated as follows :—

"Entire," when perfectly unbroken, as in figs. 13, 14, 15.

"Serrate," when resembling the teeth of a saw. (Figs. 20 and 34.)

"Doubly-serrate," when the serratures bear still smaller serratures.

"Prickly," when the angles are extended into long sharp points, as in holly.

"Crenate," or crenelled, when the edge of the leaf is fashioned as in betony and ground-ivy. (Fig. 16.)

"Ciliated," when set round with fine hairs resembling eye-lashes, and which lie in the same plane as the lamina, beautifully exemplified in the newly-expanded foliage of the beech-tree.

"Waved," when the edge is in little concaves and ridges, after the manner of the drawings of sea waves. (Fig. 12.)

In connection with this we must observe the extremity which lies remotest from the stem. It is called—

"Pointed," when as in fig. 22.

"Acute," when the point is fine.

"Acuminate," when long drawn out. (Figs. 21 and 61.)

"Obtuse," or "blunt," when rounded off.

"Abrupt," when the end seems amputated.

"Truncated," when cut off very square, as in the leaflets of many vetches, and in the tulip-tree.

"Mucronate," when a sharp little point is present, yet not produced by the gradual tapering of the leaf.

III. *The Veins.* The shape of the leaf, and the character of the margin, the apex, and the base, must needs result, in considerable degree, from the peculiarities in the distribution of the "veins," just as the configuration and general profile of an animal are mainly determined by the peculiarities of the scaffolding of bones which constitutes the skeleton. These "veins" are plainly distinguishable by holding a leaf between the eye and a sufficiently bright light, though sometimes, instead of being immersed in the substance of the leaf, they appear as a raised network upon the under-surface. Very succulent leaves, such as those of the stonecrop and the house-leek, have their veins completely concealed in the mass of investing pulp. They correspond far more nearly to the bones of an animal than to its blood-canals; and hence, when the leaf has been macerated, either by art or by exposure upon the ground to the causes which induce natural decay, and nothing but the fibres remain, the relic becomes familiarly known as the "skeleton." "Skeletonizing" leaves has become indeed, of late years, quite a favourite art, no objects being more elegant, when well prepared, and mounted under a glass shade, than the delicate fabrics which remain after maceration. Some persons call these fibres by the name of

the "nerves"—an epithet still more objectionable than "veins," since there is not the slightest reason to suppose that plants possess a nervous system. To understand the principle we are referring to (namely, that the form of the leaf is ruled by the venation), compare, for example, an ovate leaf with a palmate one, and the "entire" leaf of a lily with the prickly-edged one of the chestnut, and it will be seen at once that the veins determine the differences between each couple.

Whatever the importance of the "venation," in regard to the outline of the leaf, it is paramount in respect to the classification of plants; for, as stated above, the venation of leaves almost always corresponds alike with the structure of the stem and with that of the flower, and furnishes one of the factors of the triple basis upon which the great primary divisions are established. It is found under three principal modifications, the first of which has many varieties.

1. *Net-veined*, or *reticulated leaves*. In these the veins and veinlets, or a portion of them, branch and interlace in every direction. The varieties are as follow. (*a*) When a large and robust vein proceeds straight from the petiole to the apex, dividing the lamina into two nearly equal portions, this large and straight vein then receiving the name of the "midrib." (Figs. 26 and 27.) Sometimes the lateral veins thrown out from the midrib, proceed in parallel

lines towards the margin, as in the chestnut, when the leaf is said to be "pinnate-veined." (Fig. 20.) Sometimes they proceed in a wavy and rivulet-like manner, and are then called "wandering," or by some authors, "deliquescent," as in fig. 62. In either case, leaves with a solitary and distinct midrib belong to the "vertebrate" type.

(*b*) Sometimes the midrib has two or more large veins side by side of it, almost equal in bulk and strength. The leaf is then said to be "ribbed," as in fig. 36. Good examples occur in the common rib-wort, in the cinnamon-tree, and in the Melastoma family.

(*c*) The third variety of the net-veined is found in all those leaves the outline of which is of the palmate and fan-lobed kind. It may conveniently be termed fan-veined, the principal fibres being straight and widely divergent. (Fig. 24.)

2. *Converging-veined*, or *curvilinear* (often improperly called "parallel-veined" and "straight-veined"). This is the term applied when numerous and usually slender veins proceed from the base, run side by side, without any interlacing, and converge gradually to the point of the leaf, as in the lily-of-the-valley. (Fig. 46.) In true converging-veined leaves, the veinlets, such as they are, do not form a net-work with one another, as happens in "ribbed" leaves, but cross over nearly at right angles to the leading ones. The most remarkable

example of this structure yet discovered, is the lattice-leaf plant, or *Ouvirandra*, of Madagascar, now frequent in English hothouses. The impropriety of the term "parallel-veined" becomes obvious, when we remember that the definition of "parallel" implies an arrangement like that of the iron lines upon a railway; unless it be excused by the fact that such lines, seen in perspective, like those which indicate the courses of bricks in a wall, seem gradually to approximate, and eventually to coalesce. This is just what we may observe in a blade of grass.

Of the converging-veined type, simple as it is, there are, however, two distinct varieties. One, already indicated, and well-shown in the lily-of-the-valley, has the veins in a single stream; the other, found only in the tropical families which include the ginger-plant, the arrowroot-plant, and the banana, has them disposed in a double stream. That is to say, there is a midrib up the centre, and the side-veins flow elegantly from this, both right and left, losing themselves in beautiful curves when they reach the margin.

3. The third kind of venation is that which we find among ferns; also in the curious Japanese tree called *Salisburia* (common in good old gardens), and in a few other plants; and which presents the appearance of repeated forking, or like a letter Y bearing a smaller Y upon each of the prongs. Hence this arrangement is termed "fork-veined."

(Fig. 11.) To a certain extent it is simulated in the leaves of certain viburnums, and in many trefoils, but in all the latter the intervening spaces are filled with true net-work, a feature invariably absent from the genuine fork-veined leaves.

IV. *The Disposition of the Leaves upon the Stem.*—This, like the venation, is a matter of considerable importance, since it frequently enables us to decide what family a plant belongs to. Take a spray of beech, and it will be found that the leaves are set on singly, or one by one. They are then said to be "alternate." (Fig. 65.) If distributed very irregularly, they are said to be "scattered." In a spray of lilac, upon the other hand, the leaves grow in pairs, a condition denoted by the term "opposite"; while in the woodruff, and all of its family, they are disposed in a starlike manner. (Fig. 106.) This last is called "whorled" or "verticillate." Whorled leaves may be as few as three or four together (Fig. 60), or as many as eight or nine, as in the marestail. The doctrine originally laid down as to the cause of these differences in position was that leaves are naturally or normally *alternate;* that owing to the non-development of half as many internodes, they become opposite; and that the non-development of several internodes renders them verticillate. All these conditions may be seen in the common yellow loosestrife (*Lysimachia vulgaris*), also in the purple lythrum, and in many other plants. Even myrtles

show the change from opposite to alternate, while fuchsias and the scarlet pimpernel are apt to change from opposite to whorled. Assuming this doctrine to be the true one, we understand not only such phenomena as those just alluded to, but that the rosettes of such plants as the plantain and the houseleek represent the foliage of undeveloped stems, the leaves all being crowded together for want of internodes to throw them asunder. But the laws of leaf-arrangement are now referred wholly to profound mathematical principles, the elucidation of which constitutes "phyllotaxy." Leaves of the kind just referred to, namely, such as grow in rosettes, or in tufts close to the surface of the ground, as was pointed out when describing stemless plants, are commonly termed "radical" or root-leaves, the appearance being that they do actually spring from the root. But leaves, like stems, never arise from roots: there is always something of the nature of stem, though it may be extremely short, and almost undiscoverable. The primrose (Fig. 100), the cowslip, the dandelion, have already been cited as illustrations. It is to be observed, also, that plants which elevate genuine stems frequently possess similar tufts of radical leaves, and that in such cases there is frequently a difference of shape between them. The common hair-bell for instance, has roundish-cordate root-leaves, while the stem-leaves are linear. When it

becomes necessary to refer specially to the upper or stem leaves of a plant, they are designated the "cauline" ones.

V. The normal composition of a leaf seems to be that, as above stated, of "petiole" and "lamina." In this case the leaf is called "petiolate." But it often happens that the petiole is not developed, and that the lamina proceeds immediately from the stem. The leaf is then said to be "sessile," literally "sitting close." (Fig. 116.) If so intensely sessile as to embrace the stem, it becomes "clasping" or "amplexicaulent"; and when, as sometimes happens, the stem is actually surrounded, we have the curious condition called "perfoliate," so well shown in the common thorow-wax. (Fig. 45.) If opposite leaves thus cohere, they become "connate," beautifully shown in the chlora. (Fig. 120.) Sessile leaves are sometimes so closely packed together over the surface of the stem as to nearly or quite conceal it. They are then arranged in such a way as to remind us of the tiles of a roof, and are said to be "imbricated." (Fig. 133.) The leaves of certain thistles and other plants have the margins of their sessile leaves continued down the stem or branch, giving it a winged or bordered appearance. In this case they are called "decurrent," literally "running down." (Fig. 110.) Some plants have all their leaves petiolate; others have them all sessile; others again (of the herbaceous kind) have the radical

and lower leaves supported upon long stalks, the length of the petiole gradually diminishing as we ascend from the ground, until at last the topmost leaves, just under the flowers, are perfectly sessile. This change is greatly influenced by the circumstances in which a plant grows, as when buttercups happen to spring among high grass. That is to say, if liable to be overpowered by luxuriant neighbours, the petioles lengthen themselves sufficiently to obtain for the leaves their needful supply of air and sunshine. Simple leaves are petiolate and sessile in about equal proportion; the same may be said perhaps of divided leaves; but compound ones are almost invariably provided with petioles, and generally with very long ones. The leaves of most endogenous plants are destitute of petioles (though we have striking examples to the contrary in the leaves of the palm-tree); and those of bulbous endogens are almost always sessile. When the lamina gradually narrows into a petiole, as in the primrose, the latter is said to be "winged."

VI. *The Surface* of the leaf has likewise to be considered. The terms applied to the differences here observable, are the same as those applied to the stem, but there are many conditions of leaf-surface which do not occur elsewhere, unless casually upon the coverings of certain flowers. The principal varieties are designated as follows :—

"Glabrous," when bald, or totally devoid of down or hairiness.

"Glossy," when not only glabrous, but polished and shining.

"Downy," or "pubescent," when covered with soft, short hairs.

"Hairy," when the hairs are few and stand erect.

"Bristly," when the hairs are very stiff, as well as erect.

"Silky," when the hairs are long and white, and lie flat, as in silverweed.

"Rough," when like an elm leaf.

"Puckered," when like a primrose leaf.

"Glaucous," when of a blueish or grey-green colour, as in the carnation.

Held between the eye and the light, leaves sometimes appear pricked full of little holes, such as a needle would make. These are minute reservoirs of essential oil, rendering the leaf translucent in those places. Leaves in which they occur are said to be "dotted." Translucent dots of this kind must be distinguished from the oil-glands which present such a beautiful appearance upon the leaves of certain aromatic plants, when examined with the microscope, the *Origanum Onites* for example; they must also be distinguished (since the name is sometimes applied to both) from the ornamental spangles which dot the surface of many kinds of rhododendron leaves.

Such, then, are the leading particulars found in connection with leaves, though some others have yet

to be noticed. All recur incessantly, and in the most wonderful and beautiful counter-change and intermixture; the various outlines, edges, surfaces, etc., being combined in hundreds of different ways, and constituting the finest and oldest heraldry in the world. The rich and sumptuous variety given by *colour* is not wanting; for though the poet spoke well when he referred to "chiefly thee, gay *green*," every shade of red and yellow, the shine of gold and silver, spots of pearl, snow-white, and crimson, all are found in leaves, even during their vigorous summer life, and we all know what enchanting hues they assume in autumn. These hues, moreover, are not confined to the trees and the woodlands; none are more brilliant than those which occur in the common bramble, and even in the strawberry. Every young student of botany should form a collection of leaves, pressing them for a few days between many folds of smooth paper, so as to render them perfectly flat and dry. When viewed as transparencies against the flame of the candle, they are equal to any kaleidoscope for exquisite variety and beauty.

In many families of plants the leaves have certain appendages, the presence of which frequently helps much in determining the family, and even the species. Two principal kinds are observable, called respectively "tendrils" and "stipules."

Tendrils were adverted to when speaking of compound leaves of the "pinnate" class. They consist

of those beautiful little green fingers, which, by twisting spirally round the nearest prop, enable the plant to ascend into the air. In pinnate and binate leaves they are the midribs of undeveloped leaflets, the whole set of leaflets being sometimes changed into tendrils, as we may observe at the ends of the autumnal shoots of the everlasting-pea. When however, they occur in simple and undivided leaves, which is very singularly the case in the gloriosa and some other climbing lilies, and in the Mutisias, they consist of the greatly elongated woody framework of the leaf as a whole. Tendrils of the latter origin are "simple," but those which terminate compound leaves are almost always branched. It is important to remember, in connection with tendrils, that these organs are by no means confined to leaves. Many plants which require prehensile instruments obtain them by changing a portion of their flower-stalks into tendrils, or they twist their petioles: modes well illustrated in the grape-vine, the passion-flower, the cucumber, bryony, fumitory, the nasturtium, and many other plants, both wild and cultivated. Tendrils must also be carefully distinguished from twining *stems*, though the object to be attained by the plant is the same in both instances.

"Stipules" usually resemble a pair of little green wings, growing at the base of the petiole, one upon each side. (Fig. 28.) Sometimes they are enormous in proportion to the size of the leaf, as in the

pansy; sometimes, as in the Robinia, they are converted into a couple of sharp thorns; sometimes they are reduced to mere scales. The most striking and beautiful examples of stipules occur in peas, vetches, passion-flowers, and upon young shoots of the *Pyrus Japonica* and of the common hawthorn. Very often the stipules are cast off almost directly after the leaf expands; they are then said to be "deciduous." Sometimes they are so large as to supply the place of the leaves, which organs, in the cases referred to, are actually wanting! In the sorrel-family the stipules are membranous and translucent; uniting upon the opposite side, they encircle the stem like a sheath, whence they are called "ocreate," *ocrea*, in Latin, signifying a boot. When *opposite* leaves possess stipules, they often become "confluent," sometimes quitting their usual place, and becoming "interpetiolar." This condition of the stipules constitutes one of the special features of the coffee-tree family. Sessile leaves rarely or never possess stipules; and in endogenous plants they are always entirely wanting.

A few plants are prone, soon after they have risen from the seed, to cease the production of true and proper leaves, and to develope these organs in the shape of clusters of spines, as happens in the common furze, the first or true leaves of which plant resemble those of clover. Others flatten out their petioles into *quasi*-leaves, and had we not the two

kinds of organs side by side in certain individuals, we should not know but that these flattened petioles were the actual leaves. The Australian acacias, so common in our greenhouses, furnish an instance of this.

A few other plants are absolutely leafless, and at every period of their existence. Such, for instance, are the cactuses (excepting that one called *Pereskia*), and most of the plants which lead a "parasitic" mode of life, such as the common dodder. Such parasites as the toothwort (*Lathræa Squamaria*) have their leaves developed only as scales, in the present instance white and succulent. (Fig. 99.)

The space between the stem and the petiole of the leaf, on the upper side of the latter, is called the "axil" (literally, the "arm-pit") from its resemblance to that part of the body reversed. It is from the axils that almost all buds, twigs, and flowers are sent forth; and to denote this, when important to be taken notice of, it is said that they are "axillary." (Fig. 114 and 134.)

Upon the contrary or *under*-side of the base of the petiole, there is often a little swelling, then called the "pulvinus," or cushion. In the blushing-maiden heath (*Erica Tetralix*) this is very pretty and conspicuous, resembling a little pink jewel. In the gooseberry-bush the pulvinus grows into a great three-pronged prickle!

In regard to duration, leaves are called "ever-

green" when they remain upon the plant or tree during the winter in a green and living condition; and "deciduous" when they fall at the close of autumn. All leaves drop and are renewed sooner or later, the evergreen ones merely enjoying a longer lease, sometimes enduring for years, and helping to keep the face of nature cheerful, when evanescent summer splendours have departed. How rich and cheering at mid-winter the bright green of old England's indomitable wild holly, that sturdy and sacred bush that laughs at frost as complacently as the Christmas it decorates!

The *use* of the leaves is to convert the crude watery matter sucked up by the roots into proper vegetable substance. They have been compared, because of this, to the digestive organs of animals; and as their functions are respiratory in addition, or of the nature of breathing, they have been compared also to the lungs. To enable the breathing and digestion to proceed, the whole surface of the leaf, both on the upper side and the under, or at least in all land-plants, is clothed with a delicate skin or "cuticle," which abounds, particularly on the underside of the leaf, with little mouth-like pores, called "stomates." (Fig. 10.) These "stomates" are plainly seen with a microscope, even with one of very low power, if a piece of the skin of the leaf be stripped off and put in water, with a bit of glass over to keep it flat. The best kind of leaves to

select for the purpose are those of juicy plants, such as lilies and orchids.

Now as to the law of their action. Chemical experiments have shown that vegetable life is endued with the wonderful power of decomposing the carbonic acid of the atmosphere, and that this process is effected in the leaves, during the day-time, or when the sun shines. The oxygen is set free, and the carbon retained in the leaf, and applied, along with the water and other matters absorbed from the soil and air, to the manufacture of the wood, the pulp, the peculiar juices, and everything else that enters into the composition of the plant, each particular product being deposited in its own place, the root, or the stem, or some other part of the general storehouse. In a word, after the plant has emerged, like an infant, from the seed, its enlargement depends upon the activity of the leaves, which come out fresh and fresh every spring, work diligently all the summer, and having fulfilled their manifold and useful purposes, each in its own way, die as quietly and contentedly as they have lived, beautiful images of all true and noble souls, and in their decayed remains replenish the earth anew.

If leaves be not developed, the surface of the stem is provided with a cuticle which answers the same purpose.

## THE FLOWER.

The Flower is by no means the simple thing it appears at a distance. Ordinarily there are present in it four distinct parts, two of which are composed of still more delicate ones. There are important varieties also in the general structure of flowers, rendering it necessary to separate them at the very outset into the three following classes :—

Complete and Simple.
Complete and Compound.
Incomplete.

We shall take them in the order named, confining our attention first to Complete and Simple flowers, such as the lily, the polyanthus, and the lilac.

### THE COROLLA.

The most striking and beautiful portion of such a flower is that wherein the colour usually lies. Botanists call it the "corolla" or "little crown," the flower being the consummate glory of the plant,—that which makes and signalises its day of greatest honour, like the placing of the diadem on the brows of a king or queen. Generally speaking, or at all events in a vast number of plants, the corolla is composed of several independent pieces, which can be picked off one by one, and which, being articu-

lated to the part they stand upon, usually drop away when the flower is "overblown," or if exposed to severe weather. These pieces are called the "petals," and a flower is said to be three-petaled, four-petaled, five-petaled, etc., according to their number. In the great majority of flowers, the number of petals is three, four, or five, and hence we have the very convenient terms "trimerous," as in Fig. 129; "tetramerous," as in Fig. 126; and "pentamerous," as in Figs. 145, 146. These terms are also applied to the petals when conjoined. To find more than *six* petals is very unusual, except in "double" flowers, which have to be considered from another point of view. When more than *ten* are present, as in the fig-marigolds, and the cactus, the flower is "polypetalous," or "many-petaled." Some botanists, by an excruciating misuse of this word, make it signify that the petals, though there may be only a couple, are in no way joined to one another; overlooking the true significance of "poly," which is "many," or "numerous," and which they themselves abide by in every other word which has this prefix,—polyandrous, polygynous, etc., etc. The proper terms to apply to the independent condition referred to, are "free," or "apopetalous," not polypetalous. In many large families of plants, the petals, instead of being separate and independent, have their edges more or less united, so that the aggregate of them constitutes some kind of cup

or bell. The flower is then said to be "monopetalous" or "one-petaled" (Fig. 114), but only because of the *appearance*,—there is no such thing in nature as a really one-petaled flower; and save for the term being old and current, it would be better to discard it, as only tending to create mistakes, and supersede it with "sympetalous" or "joined-petaled." In the convolvulus and many other flowers the lines of junction are plainly evident, resembling seams, and are frequently of a darker colour than the intermediate parts of the corolla, ornamenting it with stripes. (Fig. 115). An excellent proof that "monopetalous" corollas are formed, as we say, of several distinct pieces, is furnished in the beautiful greenhouse shrub called the *Correa*, in which they readily come asunder. The corolla of the hardy garden flower called the *Phlox*, will also easily separate into its five constituent pieces. If the petals be united for only a portion of their length, as in a campanula, the corolla is said to be "lobed" or "divided," the appearance being that of a cup with deep clefts in its margin. According to the number of petals composing such corollas, they are called four-lobed, five-lobed, etc. (Fig. 152.) But we must be careful to remember that all such appearances of lobes or divisions come, in reality, of the part-way cohesion of as many distinct petals as there are points and spaces between.

Of this joined condition of the parts we have no-

tice given us, as it were, in the conjunction of the ordinary green leaves of certain plants:—those, for example, of the *Chlora* and of the teasel, and of those likewise which are placed just below the flowers of the Italian honeysuckle, constituting a green plate. It is not that cohesion of parts *commences* with the flowers, but that it is carried out in them in a more thorough and beautiful manner.

In shape, size, and position, the petals vary greatly, their differences giving rise to the chief part of the wonderful diversity so much admired in flowers. The principal distinction thus originated is that of "regular" corollas and "irregular" ones. Those are called "regular" which, like the mallow and the primrose, consist of a fixed number of petals (whether separate or united does not matter), uniform in size and figure, and arranged symmetrically round a central point, like the rays of a star. (Figs. 128, 146.) "Irregular" corollas are the contrary of this, comprising the very numerous varieties in which two or more of the petals are different from the others, both in figure and dimensions, as happens in the speedwell (Fig. 136), the sweet-pea, and the monkshood. (Fig. 97.) Occasionally, the petals, though of similar form, are of two different sizes, a large and a little one being placed alternately. In this case the corolla is still perfectly "regular," the proportions and balance being true, though the dimensions of the two sets of petals are dissimilar.

Some of the gentians supply examples, as do likewise the different species of the beautiful genus *Dicentra.* In other cases an irregular corolla *mimics* a regular one, as happens very often in the Foxglove, Verbena, and Gloxinia families, and their allies. (Fig. 132.) There is a simple and infallible rule for distinguishing all such *quasi*-regular corollas from true ones, namely: a truly regular corolla, on being revolved between the finger and thumb, presents, like a wheel, neither top nor bottom, satisfying the idea of symmetry, whichever part is uppermost and whichever part is at the side. Not so with an irregular corolla. However closely it may simulate a regular one, it shows, when we revolve it, a discordance between the upper portion and the lateral, and generally also between the upper and the lower. There is always a more or less obvious top and bottom, and there is generally in one or other of these portions some peculiar mark or colouring not exhibited in any other part, as very well shown in the speckled fifth petal of the rhododendron. In these *quasi*-regular but truly irregular corollas, there is usually also a want of uniformity in the stamens, some of these organs being longer than the others, or they are "declinate" (or curved all in one direction), or the number is less than that of the lobes of the corolla.

Next in importance, is the particular *shape* of the corolla, which of course is chiefly determined by

that of the component petals. When the latter are of equal size, and united as in Fig. 114, the corolla is termed "campanulate," or "bell-shaped;" when as in Fig. 152, it is said to be "tubular, star-shaped above;" when like the cardamine, "cross-shaped," or "cruciform" (Fig. 126); when like a buttercup, "rosaceous." (Fig. 145.) Irregular corollas, as well as regular ones, have many varieties, the principal forms receiving special names, such as "labiate," or lip-shaped, when like that of the dead-nettle (Fig. 135); "personate," when like that of the snap-dragon; "papilionaceous," or butterfly-shaped, when like that of the pea. (Fig. 80.)

## THE CALYX.

Outside and underneath the corolla there is a cup or vase, usually of green and leafy texture, generally about a quarter as large, and consisting, like the corolla, either of several independent pieces, or of a definite number of pieces more or less conjoined by their edges from the base upwards. The component pieces are called the "sepals," and the total of them is the "calyx." (Fig. 85.) While the blossom is yet a bud, the calyx encloses and protects the petals; but with the opening of the latter, it falls back, and sometimes drops off altogether. This is the case with the poppy, which has a large and beautiful calyx of two sepals, between which, when they begin to

separate, we may discern the rich crimson inner vesture, but so lightly attached are they that the expansion of the petals pushes them off at the same instant. The same deciduous character pertains to the sepals of the *Dicentra*, so that it often seems as if this beautiful flower were "naked."

The word "calyx" properly signifies "a cup"; it should be restricted, accordingly, to those examples in which the sepals are absolutely united by their margins. But it is convenient to let the word be synonymous with "sepals," whether free or conjoined, and in this extended and useful sense it is now always employed. Like the corolla, the calyx may be either "regular" or "irregular," but there are no special names applied to the various forms, except when it is convenient to describe this organ as "campanulate," "tubular," "prismatic," etc. Like the corolla, again, the calyx presents a great diversity of colours, for although nominally green and leaf-like in texture, as said above, we often find it exactly like a corolla both in hue and substance. Sometimes the calyx even eclipses the corolla, as shown in the fuchsia and the scarlet-flowering currant. It may be of almost any colour we can demand; white, for example, in the *Clerodendron Thomsonæ,* and in certain varieties of fuchsia; blue, in the sea-lavenders; crimson or yellow, in certain species of *Ribes;* and beautifully variegated, in the *Vicia Cracca,* the *Melampyrum sylvaticum,* and

many others. In the Turnip-family, although petals are present, also in the water-lilies, and other plants, the calyx indicates a strong tendency towards the petaloid condition, both as to colour and texture; and in great numbers of plants in which petals are not developed at all, the calyx at once takes their place, alike in magnitude and showiness. This is well shown in many of the Buttercup-family, such as the anemones, the clematis, the marsh-marigold, and the hepatica; also in the marvel-of-Peru.

It is known to be the calyx by analogy; it very seldom happens moreover that a brilliant corolla is destitute of protecting calyx. In other words, the outermost part of the flower, whatever its colour and texture, is, with very rare exceptions, *calyx*, under some condition or other. With flowers, as with all her other gifts, Nature, if she closes one hand in denial, straightway opens the other in munificence. In the Lily-family and its allies (Fig. 103), the calyx is almost always on a par with the corolla, both in development and lustre. Here it is known to be calyx by the *position* of the sepals, which parts, as a rule, form an outer set, alternate with the petals, and covering the edges of the latter like a curtain behind half-opened folding-doors. It is very unusual to find the petals exactly *in front* of the sepals, though a ready example of this anomaly is supplied in the common berbery. In that beautiful and well-known spring flower, the wood-anemone,

the blossoms *seem* to be formed in the same way that they are in the Lily-family,—*i.e.*, they appear to have a calyx of three white sepals, and a corolla of three petals to match, the latter placed alternately with the sepals. But all six pieces are genuine sepals, and corolla is entirely wanting. Such a condition of the flower as we find in the Lily-family,—*i.e.*, three coloured sepals and three coloured petals to correspond, scarcely ever occurs in plants that have net-veined leaves, of which the anemone is one, *Rumex* and *Begonia* perhaps supplying the exceptions; and it is equally rare to find it in flowers having more than nine stamens,—the anemone possessing a hundred or more.

In the cactus, the numerous petals and sepals are so much alike that it is impossible to say where the corolla ends and where the calyx begins; the extremely outermost and the innermost are alone of decided character. In the rhododendron, the Thunbergia, and others, the corolla is brilliant, but the calyx is reduced to a mere ring, its protective office being here subserved by special organs called "bracts." Sometimes a *portion* only of the calyx becomes petaloid, when we have, as the result, the very curious condition shown in the white-winged *Mussœnda*, and in the blue and crimson-winged *Polygalas*, one sepal being enlarged in the former, and two sepals in the latter. Sometimes the calyx becomes petaloid, the corolla remaining perfect, as

in those pretty varieties of azalea and polyanthus, called "hose-in-hose," each of which seems a flower within a flower; also in the berbery and the Mahonia. Sometimes, again, the calyx becomes immensely larger after the petals have dropped, and while the fruit is ripening, as happens very conspicuously in the alkekengi or "winter-cherry." Fine examples of the calyx in its ordinary green condition, are furnished by the primrose and cowslip, the Cobœa and the petunia. When the calyx remains until the fruit is mature, though it may partially wither, it is said to be "permanent" or "persistent,"—as excellently shown in the strawberry. When it not only remains, but actually increases in size and effectiveness, it is "accrescent." This last named condition is seen in several of the Nightshade-family (including the alkekengi, above mentioned) and in many of the Sage-family. The calyx is much more frequently "regular" than the corolla, even when the latter is quite the reverse, as in orchids; frequently, on the other hand, it is irregular when the corolla is not so. That is to say, a regular corolla is accompanied sometimes by a regular calyx, sometimes by an irregular one, and *vice versâ.*

There is one condition of the calyx which it is very important to take note of, namely, that in which we find it in the Melastomas and in many saxifrages. Here it clings, more or less perfectly,

to the surface of the rudimentary seed-pod which it invests; while, in other families, the adhesion is so thorough that the whole of the tubular portion of the calyx becomes incorporated with the seed-pod, and only the lobes or margins are left "free." In either case the calyx is said to be "adherent," and as a natural consequence of the adhesion, the seed-pod seems to be placed *beneath* the flower. This curious condition of the parts occurs in the Parsley-family, the Daisy-family, the myrtles, and many others, in some members of which, the free or unattached portion of the calyx constitutes a mere rim or raised border; while in others, such as the fuchsia, the Abelia, and the Weigela, the lobes are large and conspicuous.

Occasionally we find an additional or outer set of sepals. This occurs in the strawberry and the potentilla, also in many of the Mallow-family, in all of which plants they constitute an "epicalyx." Some authors designate them an "involucrum," but an involucrum, as we shall see presently, normally encloses *several* flowers.

Another particular, very important to notice, is the way in which the elements, both of the calyx and of the corolla, are laid or folded together, while in the bud-state. This is termed their "æstivation," just as the corresponding condition of the green leaves of the plant is their "vernation." The æstivation is varied and exceedingly curious, and

families are often distinguished by the peculiarities which it presents. When the edges of the sepals or petals simply touch, it is "valvate"; when they overlap, it is "imbricated"; if spirally rolled up, the æstivation is twisted, or contorted; sometimes, as happens in the poppy, the unexpanded petals are crumpled up like a handkerchief as it lies in the pocket. Two conditions of æstivation sometimes exist in the same flower, as in melons and fuchsias, which have a valvate calyx, but an imbricated or contorted corolla.

One term alone remains to be mentioned, before quitting the consideration of the flower,—namely the very useful and elegant, but much perverted one, "perianth."

Unfortunately this term is used in various senses by different authors,—some restricting it to the calyx of flowers that have no corolla; others applying it to such a calyx only when petaloid; while others again apply it only to such flowers as those of the Lily-family, in which the calyx and the corolla are both present, and similar in colour and texture. Etymologically, the word means "encircling the stamens and pistil"; it properly denotes both calyx and corolla, whether alike or unlike, and if no corolla be developed, then it is equivalent to "calyx." In short, the perianth is whatever surrounds the stamens and pistil, no matter whether single or twofold, coloured or plain green, excepting

only when those surroundings consist only of bracts or some kind of involucrum.

## THE PISTIL.

In the very centre of the flower (when simple and complete) stands the pistil, or in certain plants, a cluster of pistils. When solitary, this important organ usually consists of three distinct members, which in relative form and position resemble the three portions of an Ionic or a Corinthian column; the lowest member, called the "ovary," resembling the pedestal; and the uppermost one, called the "stigma," resembling the capital; while the intermediate stalk, called the "style," corresponds with the shaft. (Fig. 72.) Sometimes the style is not developed, and then the stigma sits close upon the ovary, and is said to be sessile, as in the poppy. (Fig. 124.) This last named condition is very general when the pistils are numerous, as in the buttercup. Ordinarily the pistil is hidden in the heart of the flower, concealed by the corolla. But there are examples in which it is so much elongated as to bring the stigma prominently forward, often suspending it like a beautiful gem, as in the fuchsia and other drooping blossoms, in which class it is most usual to find this elongation. (Fig. 122.) In colour it varies extremely, often matching the petals, though quite as often widely different from them. The style being an unimportant member,

and to be considered rather as a casual prolongation of the ovary, than as a special and normal part of the flower, presents few striking peculiarities, the most curious being its perfectly tubular character in certain plants; and its being, in others, either covered with delicate bodies called "collecting-hairs," or expanded at the summit into petaloid plates, as shown in the iris. The ovary, on the other hand, and the stigma, being both of them highly important, present many curious features, and demand our close examination. For in the ovary lie concealed the rudimentary seeds, and the stigma is the organ through the medium of which they are to be vitalized.

In such flowers as the common pea, and in the pæony, the ovary, on being cut open, is found to be a single chamber or "carpel," containiug numerous incipient seeds, or "ovules"; but very many other plants have their ovaries constituted of three, four, five, or many more chambers, each of which is really a little ovary in itself, the composite character being produced by their intimate lateral cohesion one with another. By-and-bye, when the ovary has ripened into a seed-pod, if the latter be of the nature of a dry shell, it usually bursts into as many pieces as there were compartments in the ovary, proving very plainly that the apparent divisions of the ovary into chambers or cells is to be understood upon the same principle as a lobed calyx or corolla.

When several carpels are present, the ovary is said to be "compound," and is further said to be two-celled, three-celled, four-celled, etc., according to the number of the constituent chambers. Compound ovaries of course occur only in flowers which have a solitary pistil; though there are plenty of examples in which a compound ovary has more than one style, as in flax, which has five styles; and plenty of others again in which, while the style is solitary, the stigmas are two, three, four, or five in number: four, for example, occurring in the willow-herb, and five in the geranium. Solitary styles almost always result from the fusion into a single shaft of as many independent styles as there are cells to the ovary, and the same is of course to be said of solitary stigmas. There are, as would naturally be expected, some singular anomalies. The flowers of thrift, for example, have five styles to a one-celled and one-seeded ovary! In shape, size, and colour the ovary varies immensely, and while usually glabrous, it is sometimes found covered with hair, or down, or minute prickles.

In one large class of plants, the ovary, instead of lying concealed in the heart of the flower, is found *underneath* it, and when so placed, often resembles a green stalk, as in willow-herbs, the Weigela, most orchids, and many kinds of cactus; while in the fuchsia and the snowdrop it seems a swollen green pedestal to the blossom. This is the condition al-

ready spoken of in the description of the calyx, the adhesion of which organ to the surface of the ovary, must needs make it seem to be *underneath* the blossom. When this happens, the ovary is said to be "inferior,"—a term intended to stand in contrast to "superior," or the condition it is in when free inside. It is seldom that the fact of such adhesion of the calyx can be demonstrated, though the doctrine is perfectly established in the melastomà-family, the members of which render it quite certain that in all such cases of "inferior" ovaries, the outermost layers, or strata, of their general skin do actually consist of inseparably attached calyx, and of course of corolla likewise. There are examples, however, of "inferior" ovaries and of inferior fruits which seem to originate in a peculiar tendency to concavity in the peduncle or flower-stalk, which, closing round its contents, puts on the appearance of the tube of a calyx. (Fig. 77.)

The peculiarities in the *stigma* consist chiefly in the marvellous diversity of its form, and the exquisite surface and colour which it presents, in an imperfect degree to the unassisted eye, and ravishingly when viewed with the microscope. Sometimes it is a mere point; sometimes it is globular, or feathered, or tufted; in the crocus it seems an orange-coloured plume; while in many of the daisy-family, it covers two recurving branches. It is important to distinguish between the branches of the style and the

stigma proper, the latter being simply the absorbent portion, and often, as for example in the iris and the Sarracenia, constituting a very small part of the stigmatic body.

## THE STAMENS.

Standing around the pistil, in all complete and simple flowers, are the bodies called "stamens," (Fig. 71 and 148) delicate organs usually consisting of a stalk called the "filament," and upon its summit a kind of head called the "anther," which is usually round, oval, oblong, or kidney-shaped. In lily-form flowers, such as true lilies and the daffodil, the stamens are exceedingly well-shown, being large and tall. They are conspicuous, too, in the fuchsia, the gentianella, and the cactus; those of the latter resemble a tassel of white silk. In the mullein, the Lancashire-asphodel, the *Bulbine,* and the spider-wort, the filaments are ornamented with coloured hairs, and a similar decoration is occasionally found upon the anther. The latter organ is a box, usually of two compartments, and containing a light powder called "pollen." Most flowers have yellow pollen, but it varies to scarlet, blue, white, as in the convolvulus, and even to *black,* as in the tulip. Every one who has watched bees at work, will remember how they creep out of the honied caverns of the flowers, all powdered and bespangled with golden dust.

The stamens are not always independent of one another. The filaments often cohere at the lower part, sometimes forming several clusters, while in the Mallow-family (Figs. 67 and 68) they cohere in such a way as to form a long vertical tube. Under such circumstances they are called "monadelphous," or united into *one* brotherhood; "diadelphous," or united into two brotherhoods, well represented in the Dicentra; and so onwards, up to "polyadelphous," or many brotherhoods.

More important, however, even than this is the circumstance of the stamens being sometimes so completely isolated and independent as to be removable from the flower without our interfering with any other organ; while in other cases they adhere to the corolla, or if the corolla be absent, then to the calyx. Under the first condition they are called "free" or "hypogynous" (Fig. 73); under the second, they are "perigynous." (Fig. 74.) The buttercup, the poppy, and the rhododendron, well illustrate hypogynous stamens; while for perigynous ones we have only to look at the rose and the lilac. Hypogynous stamens generally go along with *free* petals; and perigynous ones generally go with *united* petals. Perigynous stamens when adherent to the *corolla*, are often specified as "epipetalous." When the stamens do not exceed *ten* in number, it is further important to observe whether they are placed against the *centre* of the petals, in which case

they are called "opposite"; or whether they stand *between* the petals, when they are said to be "alternate." The latter is most usual. The matter of absolute *number* is likewise of importance, for although five, four, three, and six, are the predominant numbers, there are examples of solitary stamens; others again of two, eight, ten, and 20, and upwards; and a few even of seven, nine, eleven, and twelve stamens. To denote these absolute numbers, botanists employ the following series of terms,—

| | | | |
|---|---|---|---|
| Mon-androus | having | 1 | stamen. |
| Di-androus | „ | 2 | stamens. |
| Tri-androus | „ | 3 | „ |
| Tetr-androus | „ | 4 | „ |
| Pent-androus | „ | 5 | „ |
| Hex-androus | „ | 6 | „ |
| Hept-androus | „ | 7 | „ |
| Oct-androus | „ | 8 | „ |
| Enne-androus | „ | 9 | „ |
| Dec-androus | „ | 10 | „ |
| Dodec-androus | „ | 12 | „ |
| Icos-androus | „ | 12 to 20 or more, perigynous. | |
| Poly-androus | „ | 12 to 20 or more, hypogynous. | |

Flowers which have six, eight, or ten stamens, frequently elongate the filaments of one half the number, so as to have a longer and a shorter set; while

in certain polyandrous flowers, such as the mallow, there is a most beautiful successive increase in the length. A few families have "didynamous" stamens, that is to say, a total of four, two of which greatly exceed the other couple (Fig. 70); while in the Cabbage-family they are uniformly "tetradynamous" (Fig. 69), the total of six being constituted of four long and two short. The filaments of perigynous stamens often adhere so closely to the corolla (or to the calyx, if the corolla be absent) that they seem to be wanting altogether. In such cases the anthers are said to be "sessile," as well illustrated in the mezereon and in the primrose. (Fig. 76.)

The adhesion of the calyx to the ovary, whereby the last-named organ is rendered "inferior," of course involves the stamens, which in all the plants where this adhesion occurs, are said to be "epigynous." (Fig. 75.) Epigynous stamens are sometimes quite isolated and independent, as in the *Deutzia;* sometimes they adhere to the free portion of the calyx, as in the fuchsia. There is yet another curious condition called "gynandrous," or that in which the stamens adhere to the style, as in orchids and birthwort.

Lateral cohesion of the *anthers,* corresponding to the monadelphous condition of the filaments, occurs in the whole of the great family of which the daisy is the type; also in the pansy, the torenia, and many others. Whether free or coherent, these or-

gans, when mature, have their own peculiar modes of bursting or "dehiscence," some opening by vertical fissures, one to each lobe, others by terminal pores, or by lateral valves. There are differences also in the mode in which the anthers are attached to the filament. When held as by a little stalk, they are "innate"; when continuous, they are "adnate"; when balanced lightly, as in a lily, they are "versatile." Trifling as these differences may appear in the enumeration, they become indispensably valuable and important when employed as helps in the classification of plants. Apart from the scientific aid they render, they present to an amiable mind an inexhaustible supply of curious material for study and contemplation; and with the help of the microscope, when that priceless instrument can be pressed into our service, they are a delight and a luxury as long as we live.

Such, then, are the four grand constituent parts of Simple and Complete flowers: the calyx outermost, generally green and inconspicuous; then the corolla, usually coloured and radiant; then the stamens; and, in the midst of all, the pistil. When an extra part *appears* to be present, it is a modified form of one of these four, and is generally employed as a honey-cup or "nectary." Remarkably beautiful instances occur in the grass-of-Parnassus (Fig. 125), and in the monkshood, the nectaries of which flower are in reality petals, while those of the Par-

nassia seem to be metamorphosed stamens. The passion-flower is adorned with a splendid supplementary crown of rays (Fig. 102), and the narcissus with an elegant vase, looking like an additional corolla. (Fig. 121.)

Complete and *Compound* flowers differ from Complete and Simple ones merely in being aggregations of a considerable number of the latter description; aggregations, nevertheless, of such a nature, that until magnified, the individuals are scarcely distinguishable. The whole of them belong to one family,—that of which the common daisy is the type, and which is designated by the apt name of the *Compositæ*, so that a description of compound flowers and of the Daisy-family is virtually the same thing. Taking them, then, under their systematic name of Compositæ, the first great character is, that the flowers, which are extremely minute, and called "florets" (just as the component pieces of a compound leaf take the name of "leaflets"), are collected into flat or conical cushions, surrounded by a leafy basket, which serves as a general calyx to the whole. (Figs. 82, 84, 138.) The table-like surface upon which they stand is termed the "receptacle," or *clinanthium;* while the basket which surrounds them is technically called the "phyllary," or "anthodium." The latter term, so used, is highly objectionable, signifying, properly, "like a flower,"

just as "phyllode" signifies "like a leaf," and should be used to denote the whole head of florets. Many authors apply to it the name of "involucrum," and upon the whole, perhaps this is the best term that can be employed. The florets themselves might at the first glance be taken for stamens, so numerous are they, and so small. But they are perfect flowers in all respects. Every one of the yellow pips forming a groundsel-blossom has its own calyx, its own regularly five-lobed and tubular corolla, five stamens, and solitary pistil, with inferior ovary, and differs in no respect but that of size from a simple and regular flower of the largest dimensions. (Figs. 81, 83.) In reality there are as many simple and regular flowers, every one of them with all the parts complete, packed together in that little knob, as, with care and patience, we might reckon yellow points. The florets of compound flowers are very seldom less than ten in number; there are usually many scores, and often several hundreds. When ripe, the multitude is made plain, every ovary becoming an independent seed-like fruit, crowned with a light tuft of hairs, which enables the wind to float it away over the country. Everybody has noticed the white periwigs of the dandelion and the thistle, and how prettily the little ships sail away when blown with the breath. The marginal florets very commonly have their corollas lengthened sideways, so as to project a considerable distance beyond the edge of

the basket, and to give the flower the star-like appearance familiar in the daisy and in the magnificent aureola of the sunflower. Florets thus lengthened are called "ligulate." Sometimes the whole are ligulate, as in the hawkweed; and sometimes the whole are of the tubular form, when the blossom presents the appearance seen in the thistle,—a purple or yellow and rayless mound. When both kinds are present, the central florets are called "florets of the disc," and the marginal ones, "florets of the ray." In the genus Centaurea a third kind of floret occurs, standing in the place of the ligulate. Here it is funnel-shaped, deeply laciniated at the upper part, and destitute both of stamens and pistil. Under cultivation, the tubular florets of the centre or disc often become changed into the ligulate condition, giving the flower much the appearance of one in which the florets are all originally ligulate. Sometimes, as in the dahlia, when thus altered, the florets assume the shape of little cups; and in China-asters, and some varieties of the daisy, they become quilled.

The second grand characteristic of compound flowers is the cohesion of their five long and slender anthers, which are united at the edges, and form a vertical tube, the upper half of the style being enclosed in it, and the stigmas alone exposed to view. The only example of coherent anthers in a simple flower, that from other circumstances might be mis-

taken for a compound one, is in the little blue-headed hedgerow flower called *Jasione.*

Keeping these particulars before the mind, there never need be any difficulty in distinguishing between simple and compound flowers. In the normal condition the latter are known by their basket of florets with united anthers; in the "double" condition, under which they occur in gardens, they are told by the basket, and by the resemblance of the *quasi*-petals to ray-florets, every one of them being tubular at the base. It is by no means unusual to find simple flowers densely packed together into cushion-like heads, somewhat resembling the cornucopias of the truly compound, as in thrift, the scabious, and even in clover. The two former are even surrounded by a basket, but their anthers are free, and stand widely apart; while in clover the corolla is like that of a pea-flower, and there is no involucrum underneath.

## INCOMPLETE FLOWERS.

While Complete flowers, both simple and compound, are provided, as a rule, with a corolla, or at all events, with a calyx, "Incomplete" flowers are destitute of these parts, and occasionally have their stamens and pistils entirely unprotected, as happens in the ash-tree. The arum would be in a similar condition were it not for a special organ called a "spathe," that serves as a hood or cowl. The

flowers of our large forest-trees are in almost every case incomplete, the stamens and pistils being protected only by little scales. Grasses and sedges, instead of calyx and corolla, possess the membranous coverings exemplified in the chaff of wheat, which is no other than the withered envelope of the stamens and pistil.

A great distinction exists, however, between the flowers of the last-named plants and all others that are incomplete, namely, in the position of the separate pieces of the blossom upon the stalk. Elsewhere they are disposed in *whorls*, one set concentrically within another; but in grasses and sedges the pieces stand singly and alternately, each successive piece *above* the other, and on the opposite side; close enough, nevertheless, to form a compact enclosure. (Fig. 113).

In addition to the want of "floral envelopes," "Incomplete" flowers generally produce their stamens and pistils from different buds, as again very well illustrated in such trees as the oak and the fir. The same condition is observable in many herbaceous plants, such as nettles; and abnormally, in a good many plants belonging to families which as a rule, are perfect throughout, but include individuals deficient in one or more of the accustomed possessions. Of this kind is the common red lychnis of our woods and groves, which belongs to the same family as the pink and carnation, but is uniformly imperfect

as to its stamens and pistils. There is no rule as to the systematic place of incomplete flowers; those of some of the noblest productions of nature come permanently under this designation:—the number of tall and stately plants with flowers so formed far exceeds, indeed, that of the inconspicuous, showing that we are by no means to confuse the idea of an *incomplete flower* with that of an *imperfect plant.*

It should be added that owing to the beauty of the protective scales, and to the dense crowding of the flowers, a plant which in reality produces only these "incomplete" ones is sometimes made to appear brilliant and floriferous in the highest degree! This is the case with many Euphorbias, especially the splendid *Euphorbia Jacquiniflora*, the five vermilion bracts presenting the exact similitude of a five-lobed corolla, while the twelve or thirteen extremely minute actual blossoms seem to be stamens surrounding a solitary pistil, which body is itself another independent and intensely imperfect flower!

It is impossible to be too much on the alert in regard to the freaks and fancies of nature; and nowhere, perhaps, are we at first more puzzled and deceived than by these wayward and pantomimic Euphorbias.

## PURPOSE OF THE FLOWER.

As soon as the flower has attained its full development, and shines in the sweet perfection of

its beauty, the anthers open, and their pollen is conveyed over to the stigma. How this is effected, is not yet known, or at least very imperfectly. Insects have been supposed to aid the process, and that they are actually indispensable to it in certain classes of plants has been demonstrated by Mr. Darwin. The wafting of the air may also give a little assistance; perhaps there is some kind of attractive power in the stigma, which draws the particles of pollen towards it as soon as they come within its sphere, as a magnet draws the atoms of steel-filings, only that in the flower it is vital force instead of physical. Generally speaking, it must be regarded as one of those interesting mysteries which are reserved for the pleasure of future ages; for nature takes her own time to reveal her secrets, not telling them all at once, nor to a single generation, even to the most diligently observant, but a few to one, a few to another, alluring us no less with her riddles than with her smiles. Numberless contrivances, calculated to facilitate the process, are met with in different flowers: such as power to spring forwards on the part of the stamens, greater length of pistil in pendulous flowers, and of the stamens in erect ones, both circumstances enabling gravitation to come into play, —and presenting, in their aggregate, some of the most captivating examples of the Divine adaptation of means to ends anywhere to be found in nature. That the pollen-grains may be in no danger of fall-

ing off, or being blown away, the stigma becomes moist with a clammy exudation as soon as it is ready to receive them, and until the exudation commences, they have neither hold nor effect upon it. To the same end, the stigma is often covered with minute points, among which the pollen-grains become infixed. And, to gain time, we often find that the anthers do not burst all at once, but consecutively, so that showers of pollen may fall upon the stigma for many hours and days consecutively. This is exquisitely illustrated in the grass-of-Parnassus. The passage and the anchorage of the pollen-grains being accomplished, after a while a fine thread of semi-fluid matter exudes from the end of every grain that has effected a lodgment, and pushes its way through the style into the ovary, where it enters an ovule, fertilizing it with power to ripen into a seed. The petals and stamens, with the style and stigma, and usually the calyx, then wither more or less completely; the ovary meantime swells fast, and gradually enlarges into the "fruit."

It is truly remarkable, however, that in certain plants, such as the wood-sorrel, the violet, and the balsam, fertilization can take place within the flower-bud, or previously to its expansion, and that this curious phenomenon is occasionally attended by non-development of the petals, the indication that the process has been completed being the enlargement of the ovary.

The purpose of the calyx and corolla is thus simply to guard and shelter the stamens and pistils. They play no direct part in the preparation of the seed, as proved, negatively, by the circumstance of many flowers being devoid of them. The calyx and corolla are in fact, elegant apparel, with which nature, in her unimpeachable taste and delicacy, decks her favourites during the hours of their hymeneals, keeping it folded in reserve till the energies of stamen and pistil shall effervesce, and the poet's song of the loves of the plants become no fable. The corolla fulfils its office in the most beautiful manner. The petals are drawn together at the base, or combined into a cup; or, if unconnected, they close at night, and when it rains, so as to form a tent, in every case tenderly shielding the parts within; and when the sun glows warm and bright, they turn towards it and spread wide open, that the life-giving flood shall pour in abundantly, and be reflected from their surface, as by mirrors. The nocturnal folding of the petals serves a second purpose. While they become curtains for the interior of the flower, the inner surfaces, sprinkled with pollen, come more or less into contact with the stigma, and impregnation is facilitated.

That many plants produce their stamens and pistils in different flowers, and even upon different individuals, has already been stated. The functions above described, and the analogy they hold with

facts belonging to the history of the animal kingdom, gives to such the name of "unisexual"; those where the two kinds of organs are contained in the same blossom being called "bisexual." Individually, those flowers which possess stamens only are called "male," and those which contain pistils only "female." Most of the unisexual plants have the two kinds of flowers differently formed. The hop bears its stamens in large, light, branching clusters, while its pistils are contained in cones; in the nut and the oak the stamens grow in pendulous catkins, and the pistils are enclosed in buds. The finest examples of unisexual flowers are supplied by the cucumber-family and by Begonias. Technically, the two conditions are called "monœcious" and "diœcious," the former well represented in the nut-tree and the cucumber-plant, the latter in willows and poplars. Some authors increase the botanical vocabulary by saying "monoclinous" instead of bisexual, and "diclinous" instead of unisexual.

The design of sex is at times entirely cancelled. This happens when, under the influence of cultivation, flowers become "double," as shown in the double camellia, and a hundred others made familiar to us by the florist. The "double" condition consists in an immense extra development of the corolla, many circles of petals being produced, one within the other. Generally this is at the expense of the stamens, which, in double flowers, are usually

dilated into petals, of course losing their anthers, except in partially-double flowers, which show the transition very plainly. Partially-double tulips, white water-lilies, and camellias, often supply every gradation between perfect stamen and perfect petal. It is not *necessary* to the production of a double flower that the stamens should be changed into petals, though double flowers certainly occur oftenest where the stamens are numerous to begin with. The double columbine retains its numerous stamens, and double roses, double poppies, and many others often do the same. Nor is it necessary to the production of a double flower that the stamens should originally be numerous: as well proved by the double tulip and the double daffodil, which in their single state have only six stamens each. The pistil, like the stamens, usually disappears in double flowers; but the double pæony retains it. When the reproductive organs are metamorphosed into petals, or otherwise obliterated, of course the flower produces no seed. Hence, the great majority of double-flowered plants can only be propagated by slips or offsets. Double flowers in which the stamens and pistils remain perfect, are by some persons, for distinction sake, called "multiple"; while the doubling process itself is termed "impletion."

The Petunia, Datura, Azalea, and some other flowers, exhibit under cultivation another curious condition, having an extra corolla developed, in-

terior to the normal one, the stamens and pistil remaining perfect. This condition is popularly termed "hose-in-hose." The same term is applied to an old-fashioned variety of the polyanthus, in which the calyx assumes all the characters of the corolla, every other part of the flower remaining unaltered. Double flowers occur most frequently in families that have the stamens placed upon the receptacle. In some families, though of great extent, they never occur at all. Double-flowered liliaceous plants, the *Ribes sanguineum*, and some others, occasionally, instead of losing their stamens, increase their number!

## THE INFLORESCENCE.

With the history of the flower is intimately connected the position which it holds upon the stem. In other words, if solitary, how and whereabouts is it placed?—if one of a company, what kind of bunch or cluster does it help to form? These considerations constitute the subject of the "Inflorescence," and are often exceedingly important, certain families of plants having their flowers always or almost always disposed in a determinate manner.

As with the primary position of the green leaves of the plant, so with that of the flowers. They may either seem to be "radical," or to spring from the root, owing to the extreme shortness of the stem, as

in the primrose (Fig. 100); or they may be developed, as in the great majority of plants, from some part of the stem or branches, when they are termed "cauline."

The leafless stalk of a flower, whether radical or cauline, is termed the "peduncle"; and if it be subdivided into many smaller ones, each bearing a flower at the extremity, the latter are termed "pedicels." The peduncles of the cyclamen are "radical and solitary." When a radical peduncle bears a cluster of flowers, as in London-pride and the cowslip, it is called a "scape."

The distribution of the flowers, when these are cauline, is like that of radical ones, sometimes upon solitary peduncles, but more commonly, in some kind of cluster. The former condition admits of very little diversity, comprising no more than "solitary and terminal," as in the Adonis and the Trillium; and "solitary and axillary," as in pimpernel and the fuchsia. (Fig. 114.) "Solitary" flowers may however be very numerous, as regards the entire plant.

The forms of inflorescence in which the flowers are clustered, bear special names, and are designated as follows. These names are applied alike to the clusters of the scapescent plants, and to those of the branching ones, and are in every case converted into adjectives as well: as umbellate, corymbose, spicate, etc.

1. The "umbel," when many pedicels spring from the apex of the general flower-stalk, and point in all directions, as in the cowslip and the wax-flower. (Fig. 154.)
2. The "compound umbel," when the peduncles, instead of bearing flowers, support smaller umbels, called "umbellules." This kind of inflorescence is peculiar to the Parsley-family. (Fig. 79.)
3. The "head" resembles an umbel with the flowers all sessile, or nearly so, as in the scabious, clover, and thrift. Under its classical synonym of "capitulum," it is the form of inflorescence which pertains universally also to the "compound" flowers. The capitules themselves may be either solitary and radical, or solitary and axillary, or spicate, or corymbose, etc.
4. The "corymb," when the peduncles, instead of proceeding all from the same point, as in the umbel, spring from many different points, the outermost or marginal flowers of the general company expanding *first*, so that the blooming is "centripetal."
5. The "cyme" is much like the corymb, but the peduncles are branched, and the expansion commences in the centre of the general mass, whence it is termed "centrifugal." Another variety, represented in Fig. 107, and

illustrated in the sweet-william, is called the "fascicle."

6. The "spike," when numerous sessile flowers are packed together in such a way as to form a long, slender, and usually cylindrical cluster, like that of lavender and wheat. (Fig. 105.) The spike is sometimes several feet long, as in the hollyhock and the mullein. In the *Acorus*, the *Arum*, and their congeners, the spike is consolidated into a "spadix."

7. The "raceme," when the flowers are borne as in the "spike," but provided with pedicels, as in the laburnum and currant. The raceme is generally *pendulous*, and the spike generally *erect*. Racemes are occasionally a little branched, and in a few plants they are coiled inwards while young, like a fern-leaf, as happens in the forget-me-not, the heliotrope, and the sundew. They are then called "circinate," or "incurved." The stalk straightens as summer advances, and the curve disappears.

8. The "catkin" is a kind of raceme, composed simply of bracts and stamens or pistils. Alder and birch trees furnish examples. (Figs. 144, 155.) Carices also, and the female flowers of the hop.

9. The "panicle" is a raceme very much branched and subdivided, as in oats, and many other

grasses. (Figs. 108, 113, 118, 131.) When but slightly branched, the panicle is called "simple," and when very compact, as in privet, lilac, and bunches of grapes, and somewhat contracted at the base, it is a "thyrsus."

10. The "whorl," when flowers grow plentifully in the axils of opposite leaves, so as to form a seemingly unbroken ring around the stem, repeated on a smaller scale with every successive pair of leaves above. The yellow dead-nettle and the Lythrum have "whorled" flowers. (Fig. 139.)

The spike, the raceme, and the panicle often have their flowers all turned one way, looking in one direction, like the leaves of a parlour-geranium when drawn by the light. They are then said to be "unilateral," or "secund." The foxglove and the gladiolus supply examples.

## BRACTS.

"Bracts" have been mentioned once or twice. These are the greatly diminished leaves which occupy the space between the last of the true and perfect leaves of the plant, and the base of the calyx of the flower, the space in question being denominated the "bract-region." They bear somewhat of the same relation to the peduncles that the

stipules bear to the leaves. While stipules, however, are very often wanting, it is rare for a plant to be destitute of bracts. The Turnip-family is the only extensive one from which they are uniformly absent. Sometimes they are very large and conspicuous, and contribute greatly to the beauty of the inflorescence, as in most of the pine-apple family, and in many euphorbias. Their nature and origin are plainly demonstrated in the common black hellebore, *Helleborus fœtidus*, in which every gradation is shown, and in the most beautiful manner, between the great pedate radical leaf, and the sepals, and even the petals of the flower, which present the last and most finished step in the series of changes. This plant is the more valuable as a lesson, on account of the transition of leaves into bracts being generally very abrupt. When many bracts are developed near together, so as to constitute a regular whorl, we have an "involucrum," as happens in the greater portion of the parsley-family. They receive this name, however, only when *several* flowers are so invested. When, as in the mallow-family, the flower stands alone, the bracts constitute, as above said, an "epicalyx." When the calyx is very small, the bracts are often inordinately large, compensating its absence, as happens markedly in the common purple rhododendron. Here they remind us of the great stipules which compensate the absence of leaves in the *Lathyrus Aphaca*. Occasionally they

are produced in numbers so vast as completely to overwhelm the tiny blossoms they protect, as well-shown in the common cockscomb. Occasionally, again, they exactly simulate petals, as in the Astrantia; while in the catkin-bearing trees, such as the hazel-nut, they supply the place alike of sepals and petals! Plants that have their flowers borne on a "spadix," generally have this part enclosed, at least while young, in a prodigious bract called a "spathe." A striking and familiar illustration occurs in the common trumpet-lily, the spathe of which is six or eight inches long, and resembles an alabaster vase. The flowers of the snowdrop and narcissus are also, while young, enclosed in spathes.

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## THE FRUIT.

After the root, the stem, and the leaves have fulfilled their duties as stewards of the vegetable household, enlarging its fabric, and maintaining it in health and vigour; after the flower has been put forth, and the stamens have executed their office, and the petals that were so bright and lovely have departed, and the glory seems at an end,—the grandest event of all has yet to happen, and that is, the *ripening of the fruit*—the harvest-home of the spring and summer labours. The fruit or seed-pod is the final production of the plant. Everything that has preceded has had more or less immediate reference to it, just as all the activities and aspirations of a man's social life have reference, though it may be unconsciously and undesignedly, to domestic happiness in wife and children. Well did the old poet call flowers and fruit the "joy of plants." Here, however, we are concerned with fruits as objects of practical Botany, and must leave what in other places would be a pleasant theme; reminding the student, in the first place, that the fruit is *the enlarged and perfected ovary,* with its contents; and observing, that whatever the word "fruit" may signify in ordinary speech, botanically it means the seed-pod in its mature condition, whatever its sub-

stance, and whether fit to eat or not. The nature of the fruit, as to structure at least, of course depends upon that of the ovary. If the pistil be solitary, so will be the fruit; if there be many pistils, there will be many fruits; if the ovary be one-celled, in the ripe state it will be the same,—and so on with every other circumstance, though remarkable changes are sometimes superinduced. Ovaries, for example, that are composed of three or more cells often ripen into fruits of only one cell, in consequence of the suppression of the remainder. This occurs in the coconut, two of the original three cells of which fruit are obliterated, but leave their vestiges in the form of scars upon the lower extremity. Sometimes the ovary ripens, but the seeds do not, as happens with Sultana raisins, and in one of the varieties of the berbery. The most extraordinary of these changes consists in the enormous accumulation of juice, and sugar, or acid, or starch, or oil, or whatever else forms the special characteristic of the fruit when perfected. The component cells of the fruit are called the "carpels," and the part to which the seeds are attached is named the "placenta." Fruits which open in a regular manner when ripe, and let the seeds fall out, are called "dehiscent;" those which do not open, are called "indehiscent."

Fruits are sometimes so minute as to look like mere seeds, and, at the first glance, we might not unreasonablv suppose them to be nothing else. It

is hard to conceive, for instance, that every one of the yellow specks on the surface of a strawberry is a true and independent fruit, consisting of a matured ovary and a seed within. But such is actually the case, the crimson and juicy mound upon which they are seated being the original floor or platform of the flower, enormously enlarged, and rendered succulent. It is exactly the same with a head of ripe Indian-corn, which is a vast aggregation of seed-like fruits, closely packed together upon a conical floor or platform of similar nature, but dry and unfit for food. For all flowering-plants are likewise truly *ovary-bearing* plants; and the illusion that some have "naked seeds," as the early botanists were wont to say, comes of the minuteness, the extreme thinness, and the close-fitting character of the ovary, and of there being generally only one seed in ovaries of these small dimensions. "Naked seeds," properly, or at all events ordinarily, so called, occur only in the fir-tree family and a few others; and even in these, the nakedness, so called, comes not of the absolute absence of an ovary, but of this organ being open, instead of closed. Fruits, it should be added, are not invariably constituted of the ripened ovary and its contents *alone*. Sometimes the elements of the blossom become changed, and incorporated with the ovary proper, as happens in the fig, the mulberry, the pine-apple, the Gaultheria, and even in the apple and pear.

Nearly fifty different forms of fruit have been distinguished and named. But many of these are almost solitary examples of their kind; and the great mass of those ordinarily met with belong to only seven or eight leading types. An exact classification of fruits is still a desideratum, and until obtained, it is convenient to deal with them much after the simple manner prescribed by Linnæus, premising that the ripened ovary itself is always called the "pericarp," whatever its substance, and however complex it may be, the contents being distinguished as the seeds. When pericarps resemble seeds, they may always be distinguished by having a scar upon the summit as well as at the base; while seeds, after the same manner, when so large as to resemble pericarps, are told by having only *one* scar, usually at the side, and which indicates the former point of attachment to the placenta. Any classification that may eventually be devised will have to take for its basis the distinction of fruits into Simple and Compound, the former being resolvable into such as are simple and solitary, and such as are simple and congregated. The pod of the pea, for instance, resulting from a solitary pistil, with a one-celled ovary, and standing alone and independent, is simple and solitary. The fruit of the buttercup and of the strawberry result, on the other hand, from the aggregation of many such pistils, individually simple, though compactly associated; while

compound fruits come of the union of two or more ovaries, so thoroughly fused together as to form an organic unity. This is well shown in the three-celled capsule of the common bluebell, also in the orange and lemon. It is further important to observe that the theoretically perfect condition of a pericarp implies three distinct layers, as shown in the plum and all other stone-fruits. The skin is called the "epicarp"; the pulp or flesh is the "sarcocarp"; and the stony or membranous inmost stratum is the "endocarp." But, in the great majority of pericarps, these three portions cannot be separated or even distinguished, and very often they constitute a mere shell.

The following are the most important and the most frequent forms of the fruit.

The capsule,—a dry box, containing seeds more or less loose and numerous, as in the poppy-head and lily. (Figs. 66, 87, 91, 94.)

The apple-form, or "pome,"—as in the apple, pear, and quince.

The berry,—exemplified in the currant and gooseberry.

The one-celled pod, or "legume,"—as in peas and beans. (Figs. 86, 92.)

The two-chambered pod, or "silique,"—as in the Turnip-family. (Figs. 88 and 93.)

The "follicle,"—as in the marsh-marigold, the

larkspur, the aconite, and many others of the Buttercup-family. (Fig. 90.)

The "drupe,"—as in the cherry and plum.

The "etærio,"—consisting of numerous little one-seeded fruits placed side by side; either dry, as in the buttercup and clematis, or juicy, as in the raspberry. The hip of the rose is an *inverted* etærio. The separate fruits of an etærio are, when dry, called "achenia;" when juicy, they are little drupes or drupels. (Figs. 77, 96.)

The "caryopsis,"—as in wheat and other cereals.

The "carcerule," also resembling a seed,—as in borage, mallows, the nasturtium, and the Sage-family.

The "cypsele,"—as in the Daisy-family, again resembling a seed.

The "cremocarp,"—perhaps peculiar to the Parsley-family. (Figs. 78, 89.)

The nut,—as in acorns and filberts.

The "hesperidium,"—as in the orange and lemon.

The cone,—produced by fir-trees, pine-trees, the cedar, and the other members of the great order this fruit gives name to.

The seeds inherit the very life of the plant, since on being sown in the ground, and exposed

to the action of moisture, warmth, and air, they germinate, and produce new plants similar to the one that ripened them. The outer skin of the seed, called the "testa," is often of some lively colour, as in French and scarlet beans, which have it variously mottled with white, purple, brown, violet, and other colours. The seeds of other plants of the pea-family, brought from tropical countries, are remarkable for their brilliant orange-colour and scarlet, and the polished and shining surface. Seeds of many English wild-flowers are equally beautiful, though requiring the microscope for their peculiar character to be discerned. Those of the carnation family, the poppy, and the henbane, appear as if carved and embossed; those of orchideous plants resemble purses made of fine net, with a piece of money in the centre. On opening the seed, it is found to consist of white matter. This is generally resolvable into two distinct portions, as well shown in an almond kernel, each portion being a "seed-leaf" or "cotyledon." The cotyledons are connected by a kind of hinge, which is the "embryo" or nucleus of the future plant. At the period of germination the embryo strikes a little rootlet into the ground (the testa being ruptured by the swelling of the whole mass), and often lifts the cotyledons into the air, where they become green, and are the sign that the plants are "coming up." (Fig. 18.) Sometimes the

cotyledons remain in the earth; but in either case the embryo presently developes a "plumule," which is the beginning of the future stem, and soon commences to unfold little leaves. There are many seeds, however, in which the cotyledons are extremely minute, and lodged in a quantity of floury matter called "albumen," which nourishes the embryo when it germinates. The purpose of the cotyledons, when there is no separate store of albumen, is likewise to supply nourishment while the plant is yet too weak and tender to procure food from external sources. Hence they have been compared to the breasts of nursing mothers, and it is not difficult to see how many and close are the points of resemblance.*

We have now gone through the parts of which perfect plants are composed, and it remains but to recapitulate their names, and place them before the eye at one view.

### THE PARTS OF A PERFECT PLANT.

The Root, consisting of caudex and rootlets, which end in "spongioles."

The Stem, usually dividing into branches and twigs, and generally composed of wood, bark, and pith.

* See the author's "Life; its Nature, Varieties, and Phenomena," chap. xxiv., p. 305. (Ed. 2.)

The LEAVES, usually consisting of blade or lamina, and footstalk or petiole, and either simple or compound.

The FLOWER, consisting of
- Calyx, formed of sepals.
- Corolla, formed of petals.
- Stamens, formed of filament and anther, the latter containing pollen.
- Pistil, formed of
  - Ovary, containing ovules.
  - Style.
  - Stigma.

The FRUIT, or ripened ovary, containing Seeds.

## IMPERFECT PLANTS.

"Imperfect plants" are those in which the grand feature of the "perfect" division,—namely, the blossom, is either absent, or developed in a manner so entirely different as to have gained for them the name of "flowerless." No plants are absolutely destitute of seed-producing or reproductive powers; nor, judging from philosophical analogy, of that wonderful two-fold principle which has its highest manifestation in male and female. But there are many imperfect plants in which it is extremely difficult to make out how and whereabouts the reproductive power is effectuated, the apparatus found in perfect plants being represented

very faintly, even in the highest. Linnæus gave them the appropriate name of *Cryptogamia,* literally "hidden-flowered." Flowerless plants seldom develop stems; the greater portion are low-growing and inconspicuous, consisting merely of leafy organs, and often of nothing more than crust-like, or spongy, or thready, or fibrous matter, and, at the lowest point, of no more than a few microscopic cells of coloured fluid. In our own country, their noblest representatives are the ferns,—those charming plants that grace every wood and shady bank with green luxuriance of arching plumes, and are so curious in the brown spangles of their under-surface.

A particular account of the cryptogamia cannot possibly be attempted here. It must suffice at present to say that the principal families comprised under that general name are the

Ferns. (Figs. 123, 158.)
Mosses. (Fig. 147.)
Characeæ.
Equiseta. (Fig. 140.)
Liverworts. (Figs. 156, 157.)
Lichens.
Algæ (sea-weeds and fresh-water-weeds).
Fungi, or plants of the mushroom type. (Fig. 151.)

Imperfect or cryptogamic plants must be distinguished most carefully from perfect ones which have

merely *incomplete blossoms*, such as grasses, and most English forest-trees. Every plant that at any time produces true stamens and pistils, however inconspicuous, belongs to the "perfect" division; it is the want of these parts, at all times, that negatively marks the "flowerless," or cryptogamic. Flowerless plants, in their higher families, have organs *analogous* to stamens and pistils, but they cannot be discerned without a powerful microscope. They likewise possess very beautiful structures that take the place of calyx and corolla, and are often far more exquisitely fashioned than a large proportion of what are popularly understood as "flowers." The general term applied to the seed-producing apparatus of the flowerless plants is the same as that which is given to flowering ones, namely, the "fructification," and when their seeds are ripe or ripening, they are said to be "in fruit." The seeds of the cryptogamia, being very different however from those of other plants as to their internal structure, are designated "spores." Hence these plants are sometimes called "Sporophytes"; while flowering-plants are denominated "Anthophytes," and also "Phænogamia" and "Phanerogamia," the two last names signifying "visible-flowered."

## CLASSIFICATION.

Having surveyed plants with regard to their structure, we have now to consider the means by

which they are systematically arranged or marshalled,—a department of Botany which in importance is exceeded by no other. For the number of plants to be dealt with is so vast, that until in some measure classified, if only in theory, there can be nothing but confusion and bewilderment. The pressing consciousness of the need of classification, in the early days of Botany, originated a score of different schemes intended to meet it: so intimately is sound and philosophical Botany identified with a correct arrangement of plants according to their affinities, that the "Natural System," as it is somewhat ambitiously designated, has been from the beginning, with every genuine botanist, a paramount object of thought; and if we are still only striving to understand it, we may be satisfied, at all events, that the first principles have become visible. At first it was necessary, as a matter of course, to be content with conventional, and very limited schemes, and even with purely artificial ones. Tournefort, a famous Frenchman, constructed an ingenious system dependent chiefly upon the shape of the flower; other botanists tried to make the leaves and the fruits serve the purpose they had in view; Linnæus, who first gave solidity and coherence to botanical knowledge, skilfully took the stamens and pistils, and contrived a method which, though now superseded, has made his name illustrious for ever, so successful was it in removing the difficulties of the age, and

giving that precision and facility to botanical investigations, to which the present high position of the science of Botany is mainly owing. It begins with the simple *reckoning* of the stamens and pistils; then considers their relative length, their position, mode of cohesion, and other similar particulars; and finally gives us twenty-four "Classes," all of which are subdivided into "Orders." But this was only a part of the Linnæan system. It was by the great Swede that the ideas of genus and species were first accurately established, and whoever talks of Linnæan Botany should remember that though the classes and orders are things of the past, everything else is preserved, and though open to improvement, can never be laid aside for anything better. The Linnæan System is often called the "Artificial." This is not quite correct. Better would it be to discard both this name, and the term "Natural," and to speak of the two systems as the "Arithmetical" and the "Structural."

Classification by the Natural System begins with the separation of plants into the two grand divisions described above, under the names of "Perfect" and "Imperfect." Each of these great divisions is resolved into two classes, called "primary"; the classes are then divided into "sections," and the sections into "alliances," from which we move forwards to the "families." The family, after the same manner, consists of "genera," while every

"genus" consists of a less or greater number of "species," which are represented by thousands and millions of indviduals. It is much the same as in geography, where we first have continents, then countries, then provinces, then parishes, then towns, streets, houses, and inhabitants.

On a very slight acquaintance with flowering-plants it is found, as already once or twice indicated, that some possess *net*-veined leaves, and the remainder "straight" or *converging*-veined; further, that when the leaves are net-veined, the parts of the flower are in *fives* or *fours*, and when converging-veined, in *threes*. Further again, that the stems of the net-leaved plants are composed of distinct bark, wood, and pith; while in the converging-veined there is no such distinction, the woody portion being commingled with the pithy, and true bark entirely wanting; and lastly, that the seeds of the net-leaved plants contain (with a few exceptions) *two* embryo leaves, which, at the period of germination, usually lift themselves above the ground, and spread horizontally; while those of the converging-veined contain but *one* leaf, which, at germination, shoots up vertically, like a blade of sprouting corn. However trifling the two sets of characters may appear when stated in words, they are exponents of a thorough difference in every particular, both of structure and aspect. The two classes which they mark are called respectively EXOGENS and ENDOGENS,

the names referring proximately to the mode in which the stem increases in substance and solidity, every plant that bears a flower belonging to one or the other, and plainly declaring which. By some botanists these two great classes are called "Dicotyledones" and "Monocotyledones,"—these latter names referring to the differences in the structure of the seed.

In both classes there are departures from the typical structure; and individuals, and sometimes entire families, curiously repeat the shapes of the other; on the whole, however, the peculiar characters are constant and prominent, or at least sufficiently plain for practical purposes. One part or another is always in the front. If the leaves fail to show whether the plant be an Exogen or an Endogen, it is told by the flower; and if the flowers refuse to speak, it is told by the stem or seed. It is best always to look first, if possible, at the *flowers*, as exogens often have very narrow leaves, or very succulent ones, in which the veins either scarcely appear, or from their fewness and closeness seem parallel; while contrariwise, certain endogens have *net*-veined leaves. We must be prepared for such paradoxes, and to take the *sum total* of the characters, instead of relying upon any solitary and individual character. Many little distinctive marks, over and above the essential ones, assist the eye in determining whether a plant be Exogen or Endogen; the leaves,

for example, of Exogens, detach themselves bodily from the stem, when dead, and leave a scar, whereas the leaves of Endogens wither away without falling, and the stem retains their stumps. By reference to figs. 1 and 2, 43 and 46, and 125 and 129, the differences between the two classes will readily be understood.

## EXOGENS.

Exogens comprehend by far the larger portion of flowering-plants, though several of the most important and extensive families belong to the ranks of the Endogens. Every diversity of configuration occurs among them, and every variety of size. There are scattered up and down their various tribes, rootless plants, stemless plants, and leafless plants; many are destitute of a corolla, and in many others there is not even a calyx. Some of the most beautiful of them are aquatic. (Fig. 101.) The whole are susceptible, nevertheless, of distribution into the two great companies of Exogens with unisexual flowers, and Exogens with bisexual flowers.

1. *Unisexual Exogens.*—These comprise only about a dozen families of moment, and need no preliminary analysis. It is important, however, to remember that truly unisexual plants are such as have the two kinds of reproductive organs, stamens and pistils, always apart and isolated, and the inflorescence and the perianth usually of different character in each of

the sexes, intimating at a glance which is which, after the manner of human dress. Plants which are unisexual only by the non-development of either stamens or pistil, such as the common red lychnis, are, in classification, always associated with their immediate kindred, and regarded simply as exceptional to the family structure.

2. *Bisexual Exogens.*—While most flowering-plants are Exogens, the Exogens, in turn, are mostly bisexual. How to classify these becomes the next consideration, and a seriously important one, since the families are very numerous, while in regard to the grand preliminary groups which undoubtedly they are referable to, Nature has refused to disclose her plan with perspicuity. The beginning and the ending are made plain, but the space lying between is half-hidden. There is no doubt, that is to say, as to the bisexuality, and none as to the distinctiveness of the 200 families, but how are these 200 families to be marshalled? One school of botanists breaks them up, primarily, into such as possess both calyx and corolla, or the "Dichlamydeæ";—such as possess calyx *only*, or "Monochlamydeæ";—and such as are totally destitute of true perianth, calling the last-named, "Achlamydeæ." The dichlamydeous plants they again throw into two sub-classes, viz.:—

(1) Apopetalæ, or such as have *free* petals, and (2) Sympetalæ or Corollifloræ, or those with *united* petals; the Apopetalæ being resolved, in turn, into

(*a*) Thalamifloræ, or families with hypogynous stamens; and (*b*) Calycifloræ, or families with perigynous stamens.

The second and third sections, being of small extent, do not call for subdivision, and the Achlamydeæ, in fact, are now generally associated with the Monochlamyds. The botanists who adopt this scheme, generally incorporate the unisexual plants among the bisexual ones, referring all exogens whatever to the classes and sections above named.

The arrangement is meritorious, without doubt. The construction of a class for monochlamydeous plants alone is, however, decidedly bad, seeing that to be destitute of a corolla is a purely accidental circumstance, and that the real relationships of the monochlamydeous plants lie not with one another, but with the dichlamydeous families. To maintain a separate class for achlamydeous plants is still worse. The exceptions, moreover, are innumerable. How many Ranunculaceæ are destitute of a corolla! How many Calycifloræ are destitute of a calyx deserving the name! The method described appears, accordingly, neither so natural nor so eligible as that one which, disregarding the uncertain distinction of presence or absence of corolla, first keeps rigorously asunder the truly unisexual plants; and then, occupying itself with the bisexual ones, takes the peculiarities of the reproductive organs, described on pp. 69, 71, and disposes the families

simply and at once under the three following heads, and which are illustrated in figs. 73, 74, 75.

1. *Hypogynous Exogens.* Ovary free inside the perianth, the whole of which is removable without touching the ovary; the stamens standing upon the receptacle, and thus equally free and independent. The ovaries may be numerous. The petals may be either free, or combined, or wholly wanting.
2. *Perigynous Exogens.* Ovary as in the first class, but the stamens adherent to the perianth. The ovaries may here again be numerous. In other cases, petals may be wanting.
3. *Epigynous Exogens.* Ovary "inferior," owing to the adhesion to it of the calyx-tube, or to its being sunk in an urn-like receptacle, and of course, always solitary. The presence or absence of corolla immaterial.

It is true that by this latter scheme we are at times constrained to be inconsistent. By reason, for example, of the different position of the ovary, the whortleberries are dissociated from the heaths, and the cucurbits from the passion-flowers, though in other respects there is intimate relationship; while the Epacris, which has epipetalous stamens, is nevertheless located among the hypogynous families; and worse still, there are among the saxifrages, both perigynous species and epigynous ones! The exceptions, however, are far less numerous than in the

scheme first described; and a larger proportion of related families are brought into proximity.

Anomalies such as we have indicated, are a part of the very nature of things, and render it utterly impossible to construct classes, and to frame definitions, that shall be mathematically exact, and contain nothing but what they profess to. When we quit our chairs and go to nature, we find our ingenious fences broken down—our carefully drawn lines of demarcation vague and unreal. The utmost we can hope to accomplish in classification is to associate things round certain typical and central ideas, sufficiently well for practical purpose; and we may deem ourselves fortunate in the degree that the exceptions to those central ideas are fewer and less embarrassing.

## ENDOGENS.

Endogens comprise all plants of the grass kind, together with sedges, rushes, and the choice tribes represented in the hyacinth, the orchis, and the lily. (Fig. 103.) In hot countries, their circle is widened by the glorious palm-trees, which, with a few exceptions, also tropical, are the only arborescent members of the class. Except in green-houses, we never see endogenous trees in England; and even the captives in our conservatories, with all their green and beautiful aspiration, give but a faint idea of the dignity of Endogens as they are in the Indies. En-

dogens are resolvable into three principal sections. Those of the first section have complete and usually brilliant flowers, and are called "Petaloid"; those of the second section have their flowers disposed upon a "spadix," with a "spathe" around it, and are called "Spadiceous"; those of the third are incomplete and chaff-like, and have the bracts which constitute their flowers disposed *alternately*, and are termed "Glumaceous." Endogens also include some plants of extremely low organisation, not practically referable to any of the three general sections, such as the Lemna or duck-weed; and also some plants with extremely incomplete flowers, such as the club-rush or Typha. These are technically "spadiceous," and are placed in the second section.

FLOWERLESS or imperfect plants present themselves, like the nobler half of botanical nature, under two principal aspects. The species are innumerable; they belong, however, to very few distinct families. The higher forms comprise ferns, mosses, liverworts, the plants called Lycopodium and Selaginella, and the antique "horsetails" or Equiseta; and from the circumstance of their possessing leafy organs, and more or less of an upright stem or stalk, with veins and woody fibres in it, are distinguished, technically, as CORMOGENS. The lower forms comprise sea-weeds, lichens, fungi (or mushrooms and toadstools, of all kinds), also the hair-like Confervæ of fresh water,

and some other singular productions. As a whole, they are rarely green, and never produce stem or leaves, consisting of little more than masses of cellular matter, though the figures are often remarkably beautiful and symmetrical. An entirely new world is opened among them by the microscope, which reveals shapes and phenomena of inexpressible wonder. They are collectively called THALLOGENS.

But while separated so decidedly in type or central plan, these four great classes, Exogens, Endogens, Cormogens, and Thallogens, are not exact and rigid in their *boundaries*. There are many curious plants which stand intermediately between them, giving a hand to each, and thus linking the whole into one grand confraternity. The *Paris*, the American *Trilliums*, the Smilax-family, the *Lapageria*, and the *Tamus*, which festoons the autumn hedges with vegetable coral, unite the Exogens to the Endogens; fir-trees touch both Exogens and Cormogens; and midway between the Exogens and the Thallogens stand some extraordinary parasitic plants, having the substance of a mushroom, but the ordinary characters of the flowers of the former. Intermediates of similar nature connect every subordinate class and family, locking all together in reciprocal affinity.

These things again plainly show how futile must be attempts to put the objects of the vegetable king-

dom in a line, beginning with the noblest, and ending with the humblest. And yet this has been the aim and cherished fancy of many men who, captivated by the ancient and sonorous suggestion of a universal "chain of nature," have thought labour alone was necessary to arrange everything in exact sequence. There is no such line in nature. It is easy to pick out plants that can be placed in lineal order, but thrice as many must be omitted as incompatible. The true relation which the four great primary classes bear to one another is represented in the following diagram, wherein are introduced also the names of the principal intermediates :—

ENDOGENS<br>
↑<br>
Tamus<br>
↑<br>
EXOGENS<br>
↙ ↘<br>
Coniferæ Rafflesia<br>
↙ ↘<br>
CORMOGENS THALLOGENS

Exogens, as comprising the most highly developed plants, occupy the central position, and at equal distances stand the Endogens, Cormogens, and Thallogens, with their respective intermediates between. Everything stands tolerably near to its related forms; and if we think of the noblest Exogen as the heart

of a solid sphere, over the surface of which are diffused the lowest kinds of Endogens and of imperfect plants, the successively nobler lying within and filling up the space, we may conceive how things stand related in actual fact, and how every plant has affinities on all sides. That this is the correct and philosophical view of the matter, is shown at length in the author's work upon Life, already referred to, wherein also are copious illustrations from the analogies of the Animal Kingdom.

But on paper we must needs proceed in a straight line, taking things in the most natural succession that writing will permit. It becomes convenient, accordingly, to describe the classes and the families in the order in which they have been mentioned, and of which the following table is a summary:—

A. PERFECT, or FLOWERING PLANTS.

Class 1. EXOGENS.

Section 1. *Bisexual Exogens.*

Group 1. Ovary free inside the perianth; stamens upon the receptacle.

Group 2. Ovary free inside the perianth; stamens upon the calyx or corolla.

Group 3. Perianth adherent to the ovary, and, along with the stamens, apparently upon the summit of it.

Section 2. *Unisexual Exogens.*

Class 2. Endogens.

Section 1. *Petaloid.*

Section 2. *Spadiceous.*

Section 3. *Glumaceous.*

Families intermediate between Exogens and Endogens.

Families intermediate between Exogens and Cormogens.

Families intermediate between Exogens and Thallogens.

B. Imperfect, or Flowerless Plants.

Class 3. Cormogens.

Class 4. Thallogens.

Some authors prefer to commence with the lowest forms, or Thallogens, and proceed from the simple to the complex. In practice it is better to take the most intelligible objects in the first place, beginning with those in which every member is plainly distinguishable, and in which every function is performed by a special organ; and moving gradually from these to the humble forms in which organs disappear, and functions are no longer distributed. In studying Zoology, it is found best to begin with Man, and move downwards to the animalcule, and a similar course is the most practical in Botany.

## THE FAMILIES OF PLANTS.

A family of plants comprehends all those in a given class and section which are intimately alike

in general structure, and usually bear a striking outward likeness in addition. The members are referable, for the most part, to some well-marked vegetable type, and seem to cluster, as to their characters, round a particular form which concentrates the natures of all. This central or concentrative form is used as the *name* for the family. The "Buttercup-family" is that of which the buttercup is representative; the "Turnip-family," that of which the garden-turnip is the type; and so with all the others. Every family has its Latin or technical name as well as its English one, and as a general rule this is founded, like the English name, upon the Latin term for the principal representative. For example, the buttercup being in Latin called *Ranunculus*, the Buttercup-family is named *Ranunculaceæ*; and the water-lily being in Latin *Nymphæa*, the Waterlily-family is *Nymphæaceæ*. The termination *aceæ* marks the names of the families in almost every instance, and some botanists employ it universally. The exceptions occur in the names of the Pea-family, or *Leguminiferæ*; the Parsley-family, or *Umbelliferæ*; the Daisy-family, or *Compositæ*, and a few others in which some striking particular of structure furnishes a still more appropriate name than is supplied even by the representative or central member.

A few others are simple plurals, as Gramina, Lichenes, Palmæ, Filices, Fungi, Algæ, there being

no such genera as Gramen, Palma, or Filix; wherefore to say, as some do, Gramin*aceæ*, Filic*aceæ*, etc., is altogether indefensible. Many botanists call the families "Natural Orders,"—an echo of the Latin "Ordines Naturales."

The exact *boundaries* of the several families are often somewhat uncertain, because on the confines they are prone to mingle, like the natives of contiguous countries. For the true idea of them we must look, accordingly, to the *centre*, finding that centre by the name, and determining them not so much by what they strictly *ex*clude, as by what they obviously and unmistakably *in*clude. But it must not be thought that all the members of a family resemble the typical one in colour, bulk, and stature. Trees and herbaceous plants, land-plants and aquatics, may all be comprised in a single family; differences of size, colour, and place of growth being circumstances compatible with completest resemblance as to essentials. Nor must it be supposed that all plants can be referred off-hand to their proper families. The affinities of many are very difficult to determine: so that, by different authors, the same plant is often placed in a different family. Such discord will of course cease, or at least diminish, in course of time, according as the true affinities of plants are ascertained, as well illustrated in the case of the Parnassia, which by some writers has been associated with the sundews,

by others with the St. John's-worts, but which is now seen to be in reality one of the Saxifrage-family. One of the chief ends and objects of Botany, as said before, is the determination of the affinities of plants, and consequently until every plant in the world shall be perfectly well understood, as regards its form, Botany will still be only in progress, and botanists must needs be perplexed: in other words, we must not expect to perceive on the instant what can be possessed only as the reward of the diligence and study of generations. All the great and important families are, however, known and clearly defined, and the number of *common* plants that are as yet ill-understood is very small indeed. The concurrence as to general properties among the members of a family was mentioned some pages back. There is an agreement also in the very nature of the sap. Trees of the same family graft readily with one another, but those of *different* families are indisposed to unite, even if they do not absolutely refuse, showing at once which of a large company are aliens, and which have real affinity. The plants of the Ash-tree family and those of the Jessamine-family were once thought nearly related; but although the former are somewhat heterogeneous, they graft readily on each other's branches, while the Jasminaceæ, which they resemble superficially, refuse to combine with them.

The families of plants vary greatly in extent.

Some contain but half-a-dozen species; others many thousands; their own numbers, so far as ascertained, being about 300. Of course, botanists differ a good deal as to the amount of divergence from the central or typical idea which shall still be compatible with it. Some are for excessive synthesis; others for excessive analysis. The Geranium-family, with the former, includes the wood-sorrels, nasturtiums, and flax; but with the latter, these plants are representatives of a corresponding number of distinct and separate families. For the purposes of students, it is better, perhaps, that such plants should be regarded as forming many small families rather than one great family; since if things be massed too much together, the tendency is to render inquiry superficial, and to neutralize the characters, by multiplying the exceptions. Families are seldom confined to a single country, usually spreading all over the world, though more plentifully in some latitudes than others, according as they are fond of heat or cold, aridity or moisture. Most are represented in the tropics, but some are almost entirely extra-tropical. It is curious to see how families eminently belonging to warm countries, such as the Malvaceæ, creep, in a few species, into cold ones, like beams of light stretching faintly into distant darkness, as if they would invite us to visit the realms of their magnificence.

## ALLIANCES.

"Alliances" are sets of families, not exceeding half a dozen or so, which strongly resemble one another in several leading points. They are much more difficult of determination than the families themselves, since the resemblances are often such as considerable practice will alone enable the student to appreciate. It is better, accordingly to leave the study of them until the characters, in all their variableness, of the families shall have been pretty well mastered, and the way be prepared for apprehending the niceties and minutiæ on which they depend. Lindley's "Vegetable Kingdom" may then be taken as the text-book. The names of the Alliances invariably end in *ales*, and are formed from those of the principal families which they severally include, or from some central and typical plant: Ranales, for instance, from Ranunculaceæ; Daphnales, from Daphne.

In the following list are included all the Alliances and their component Families which have indigenous representatives in Great Britain; and all the exotic ones that are of importance and practical interest to British botanists. Many more *families* have been discriminated, but the plants constituting them are few in number, and are either scarcely known, except in great herbariums, or of such rare occurrence in gardens and conservatories as not to come within the scope of a work proposing to deal

only with what is native, popular, and ordinarily cultivated. The "Vegetable Kingdom" must be consulted for particulars respecting them, should the student wish to pile up book-knowledge of what he is not likely to see living.

The names of the principal families, or those to which the student should give his first and keenest consideration, are printed in capitals, and all but those which are marked with an asterisk (*) have indigenous representatives in the British islands.

## LIST OF THE ALLIANCES AND FAMILIES.

### CLASS I.—EXOGENS.

#### SECTION 1.—BISEXUAL EXOGENS.

GROUP 1.—*Ovary free within the Perianth. Stamens placed upon the Receptacle. (Hypogynous.)*

VIOLALES.

| English Name. | | Latin Name. |
|---|---|---|
| * Passion-flower Family | ... ... ... ... ... | *Passifloráceæ.* |
| Violet ,, | ... ... ... ... ... | *Violáceæ.* |
| Frankenia ,, | ... ... ... ... ... | *Frankeniáceæ.* |
| Tamarisk ,, | ... ... ... ... ... | *Tamaricáceæ.* |
| Stonecrop ,, | ... ... ... ... ... | *Crassuláceæ.* |

CISTALES.

| | | |
|---|---|---|
| Cistus Family | ... ... ... ... ... ... ... | *Cistáceæ.* |
| TURNIP ,, | ... ... ... ... ... ... ... | *Crucif'eræ.* |
| Mignonette,, | ... ... ... ... ... ... ... | *Resedáceæ.* |
| * Caper ,, | ... ... ... ... ... ... ... | *Capparidáceæ.* |

MALVALES.

| | | |
|---|---|---|
| * Byttneria Family | ... ... ... ... ... ... | *Byttneriáceæ.* |
| * Trophy-wort ,, | ... ... ... ... ... ... | *Tropæoláceæ.* |
| MALLOW ,, | ... ... ... ... ... ... | *Malváceæ.* |
| Lime-tree ,, | ... ... ... ... ... ... | *Tiliáceæ.* |

### Sapindales.

| English Name. | Latin Name. |
|---|---|
| * Tetratheca Family | *Tremandráceæ.* |
| Milk-wort ,, | *Polygaláceæ.* |
| Bladder-nut ,, | *Staphyleáceæ.* |
| *Horse-chestnut ,, | *Sapindáceæ.* |
| Maple ,, | *Aceráceæ.* |
| * Malpighia ,, | *Malpighiáceæ.* |

### Guttiferales.

| | |
|---|---|
| * Camellia Family | *Ternströmiáceæ.* |
| St. John's Wort ,, | *Hypericáceæ.* |

### Nymphales.

| | |
|---|---|
| Water-lily Family | *Nymphæáceæ.* |
| * Nelumbium ,, | *Nelumbiáceæ.* |

### Ranales.

| | |
|---|---|
| * Magnolia Family | *Magnoliáceæ.* |
| * Dillenia ,, | *Dilleniáceæ.* |
| Buttercup ,, | *Ranunculáceæ.* |
| * Sarracenia ,, | *Sarraceniáceæ.* |
| Poppy ,, | *Papaveráceæ.* |

### Berberales.

| | |
|---|---|
| Sundew Family | *Droseráceæ.* |
| Fumitory ,, | *Fumariáceæ.* |
| Berbery ,, | *Berberidáceæ.* |
| *Grape-vine ,, | *Vitáceæ.* |
| * Sollya ,, | *Pittosporáceæ.* |

### Ericales.

| | |
|---|---|
| * Epacris Family | *Epacridáceæ.* |
| Pyrola ,, | *Pyroláceæ.* |
| Monotropa ,, | *Monotropáceæ.* |
| Heath ,, | *Ericáceæ.* |

### Rutales.

| | |
|---|---|
| * Orange Family | *Aurantiáceæ.* |
| * Melia ,, | *Meliáceæ.* |
| * Sumach ,, | *Anacardiáceæ.* |
| * Rue ,, | *Rutáceæ.* |
| * Ailanthus ,, | *Xanthoxyláceæ.* |
| Elatine ,, | *Elatináceæ.* |

### Geraniales.

| | |
|---|---|
| Flax Family | *Lináceæ.* |
| Woodsorrel | *Oxalidáceæ.* |
| Touch-me-not Family | *Balsamináceæ.* |
| Geranium ,, | *Geraniáceæ.* |

### Silenales.

| English Name. | Latin Name. |
|---|---|
| Carnation Family | *Caryophylláceæ.* |
| Illecebrum ,, | *Illecebráceæ.* |
| Purslane ,, | *Portulacáceæ.* |
| Rhubarb ,, | *Polygonáceæ.* |

### Chenopodales.

| | |
|---|---|
| * Marvel-of-Peru Family | *Nyctagináceæ.* |
| * Rivina ,, | *Phytolaccáceæ.* |
| Amaranth ,, | *Amarantáceæ.* |
| Spinach ,, | *Chenopodiáceæ.* |

Group 2.—*Ovary free within the Perianth. Stamens arising from the Calyx or Corolla. (Perigynous.)*

### Ficoidales.

| | |
|---|---|
| * Ice-plant Family | *Mesembryáceæ.* |
| Scleranthus ,, | *Sclerantháceæ.* |

### Daphnales.

| | |
|---|---|
| Mezereon Family | *Thymeláceæ.* |
| * Protea ,, | *Proteáceæ.* |
| Cinnamon ,, | *Lauráceæ.* |

### Rosales.

| | |
|---|---|
| * Calycanthus Family | *Calycantháceæ.* |
| Pea ,, | *Leguminósæ.* |
| Plum ,, | *Drupif'eræ.* |
| Apple ,, | *Pomif'eræ.* |
| Lady's-mantle ,, | *Sanguisorbáceæ.* |
| Rose ,, | *Rosáceæ.* |

### Saxifragales.

| | |
|---|---|
| Saxifrage Family | *Saxifragáceæ.* |
| * Hydrangea ,, | *Hydrangeáceæ.* |
| * Cunonia ,, | *Cunoniáceæ.* |
| Lythrum ,, | *Lythráceæ.* |

### Rhamnales.

| | |
|---|---|
| Elm-tree Family | *Ulmáceæ.* |
| Buckthorn ,, | *Rhamnáceæ.* |
| Spindle-tree ,, | *Celastráceæ.* |
| * Halesia ,, | *Styracáceæ.* |

### Gentianales.

| | |
|---|---|
| Holly Family | *Aquifoliáceæ.* |
| Periwinkle Family | *Apocynáceæ.* |
| Tooth-wort ,, | *Orobancháceæ.* |
| Gentian ,, | *Gentianáceæ.* |

### SOLANALES.

| English Name. | | Latin Name. |
|---|---|---|
| LILAC Family | ... ... ... ... ... ... | *Oleáceæ.* |
| POTATO ,, | ... ... ... ... ... ... | *Solanáceæ.* |
| *Wax-flower ,, | ... ... ... ... ... ... | *Asclepiadáceæ.* |
| Convolvulus ,, | ... ... ... ... ... ... | *Convolvuláceæ.* |
| Dodder ,, | ... ... ... ... ... ... | *Cuscutáceæ.* |
| Phlox ,, | ... ... ... ... ... ... | *Polemoniáceæ.* |

### CORTUSALES.

| | | |
|---|---|---|
| * Nemophila Family | ... ... ... ... ... ... | *Hydrophylláceæ.* |
| Thrift ,, | ... ... ... ... ... ... | *Plumbagináceæ.* |
| Ribwort ,, | ... ... ... ... ... ... | *Plantagináceæ.* |
| PRIMROSE ,, | ... ... ... ... ... ... | *Primuláceæ.* |
| * Ardisia ,, | ... ... ... ... ... ... | *Myrsináceæ.* |

### ECHIALES.

A.—Flowers regular.

| | | |
|---|---|---|
| * Jessamine Family | ... ... ... ... ... ... | *Jasmináceæ.* |
| * Heliotrope ,, | ... ... ... ... ... ... | *Ehretiáceæ.* |
| * Nolana ,, | ... ... ... ... ... ... | *Nolanáceæ.* |
| BORAGE ,, | ... ... ... ... ... ... | *Borragináceæ.* |

B.—Flowers irregular.

| | | |
|---|---|---|
| SAGE Family | ... ... ... ... ... ... ... | *Labiátæ.* |
| Verbena ,, | ... ... ... ... ... ... ... | *Verbenáceæ.* |
| * Selago ,, | ... ... ... ... ... ... ... | *Selagináceæ.* |

### BIGNONIALES.

| | | |
|---|---|---|
| * Gloxinia Family | ... ... ... ... ... ... | *Gesneráceæ.* |
| * Bignonia ,, | ... ... ... ... ... ... | *Bignoniáceæ.* |
| * JUSTICIA ,, | ... ... ... ... ... ... | *Acantháceæ.* |
| FOXGLOVE ,, | ... ... ... ... ... ... | *Scrofulariáceæ.* |
| Butterwort ,, | ... ... ... ... ... ... | *Lentibulariáceæ.* |

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GROUP 3.—*Perianth and Stamens upon the summit of the Ovary. (Epigynous.)*

### CAMPANALES.

| | | |
|---|---|---|
| Campanula Family | ... ... ... ... ... ... | *Campanuláceæ.* |
| Lobelia ,, | ... ... ... ... ... ... | *Lobeliáceæ.* |
| * Goodenia ,, | ... ... ... ... ... ... | *Goodeniáceæ.* |
| * Stylidium ,, | ... ... ... ... ... ... | *Stylidiáceæ.* |
| VALERIAN ,, | ... ... ... ... ... ... | *Valerianáceæ.* |
| Scabious ,, | ... ... ... ... ... ... | *Dipsacáceæ.* |
| DAISY ,, | ... ... ... ... ... ... | *Compositæ.* |

### MYRTALES.

| English Name. | Latin Name. |
|---|---|
| * Combretum Family | *Combretáceæ.* |
| * Fringe-myrtle ,, | *Chamælauciáceæ.* |
| Water Featherweed,, | *Halorageáceæ.* |
| FUCHSIA ,, | *Onagráceæ.* |
| * Melastoma ,, | *Melastomáceæ.* |
| * MYRTLE ,, | *Myrtáceæ.* |

### CACTALES.

| | |
|---|---|
| * Chili-nettle Family | *Loasáceæ.* |
| * CACTUS ,, | *Cactáceæ.* |

### GROSSALES.

| | |
|---|---|
| CURRANT Family | *Grossuláceæ.* |
| * Escallonia ,, | *Escalloniáceæ.* |
| * Mock-orange | *Philadelpháceæ.* |

### CINCHONALES.

| | |
|---|---|
| Whortleberry Family | *Vacciniáceæ.* |
| * COFFEE-TREE ,, | *Cinchonáceæ.* |
| Honeysuckle ,, | *Caprifoliáceæ.* |
| WOODRUFF ,, | *Galiáceæ.* |

### UMBELLALES.

| | |
|---|---|
| PARSLEY Family | *Umbellif'eræ.* |
| Ivy ,, | *Araliáceæ.* |
| Dogwood ,, | *Cornáceæ.* |

### ASARALES.

| | |
|---|---|
| Sandal-wood Family | *Santaláceæ.* |
| Mistletoe ,, | *Lorantháceæ.* |
| Birthwort ,, | *Aristolochiáceæ.* |

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## SECTION 2.—UNISEXUAL EXOGENS.

### AMENTALES.

| | |
|---|---|
| BIRCH-TREE Family | *Betuláceæ.* |
| WILLOW ,, | *Salicáceæ.* |
| Sweet-gale ,, | *Myricáceæ.* |
| * Shepherdia ,, | *Elæagnáceæ.* |

### URTICALES.

| | |
|---|---|
| Nettle Family | *Urticáceæ.* |
| Hornwort ,, | *Ceratophylláceæ.* |
| HEMP ,, | *Cannabináceæ.* |
| * MULBERRY,, | *Moráceæ.* |
| * Plane-tree,, | *Platanáceæ.* |

EUPHORBIALES.

| English Name. | Latin Name. |
|---|---|
| SPURGE Family ... ... ... ... ... ... | *Euphorbiáceæ.* |
| Water-starweed ,, ... ... ... ... ... ... | *Callitricháceæ.* |
| Crowberry ,, ... ... ... ... ... ... | *Empetráceæ.* |
| * Pitcher-plant ,, ... ... ... ... ... ... | *Nepentháceæ.* |

QUERNALES.

| | |
|---|---|
| OAK Family ... ... ... ... ... ... ... | *Coryláceæ.* |
| * Walnut ,, ... ... ... ... ... ... ... | *Juglandáceæ.* |

GARRYALES.

| | |
|---|---|
| * Garrya Family ... ... ... ... ... ... ... | *Garryáceæ.* |

CUCURBITALES.

| | |
|---|---|
| CUCUMBER Family ... ... ... ... ... ... | *Cucurbitáceæ.* |
| * Begonia ,, ... ... ... ... ... ... | *Begoniáceæ.* |

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## CLASS II.—ENDOGENS.

NARCISSALES.

| | |
|---|---|
| * Pine-apple Family ... ... ... ... ... ... | *Bromeliáceæ.* |
| SNOWDROP ,, ... ... ... ... ... ... | *Amaryllidáceæ.* |
| CROCUS ,, ... ... ... ... ... ... | *Iridáceæ.* |

AMOMALES.

| | |
|---|---|
| * Banana Family... ... ... ... ... ... ... | *Musáceæ.* |
| * GINGER ,, ... ... ... ... ... ... ... | *Scitamin'eæ.* |

ORCHIDALES.

| | |
|---|---|
| ORCHIS Family ... ... ... ... ... ... ... | *Orchidáceæ.* |

XYRIDALES.

| | |
|---|---|
| * Spiderwort Family ... ... ... ... ... ... | *Commelynáceæ.* |

JUNCALES.

| | |
|---|---|
| RUSH Family ... ... ... ... ... ... ... | *Juncáceæ.* |
| Sweet-flag ,, ... ... ... ... ... ... ... | *Orontiáceæ.* |

LILIALES.

| | |
|---|---|
| LILY Family... ... ... ... ... ... ... | *Liliáceæ.* |
| Colchicum ,, ... ... ... ... ... ... ... | *Melantháceæ.* |

ALISMALES.

| | |
|---|---|
| Alisma Family ... ... ... ... ... ... ... | *Alismáceæ.* |

**Arales.**

| English Name. | Latin Name. |
|---|---|
| Duckmeat Family | *Lemnáceæ.* |
| Reed-mace ,, | *Typháceæ.* |
| Arum ,, | *Aráceæ.* |

**Palmales.**

| | |
|---|---|
| * Palm-tree Family | *Palmæ.* |

**Hydrales.**

| | |
|---|---|
| Frog-bit Family | *Hydrocharidáceæ.* |
| Pondweed ,, | *Naiadáceæ.* |

**Glumales.**

| | |
|---|---|
| Grass Family | *Gramina.* |
| Sedge ,, | *Cyperáceæ.* |
| Pipewort ,, | *Eriocauláceæ.* |

## INTERMEDIATE FAMILIES.

| | |
|---|---|
| * Cycas Family | *Cycadáceæ.* |
| Fir-tree ,, | *Coniferæ.* |
| Yew-tree ,, | *Taxáceæ.* |
| Tamus ,, | *Dioscoreáceæ.* |
| Trulove ,, | *Trilliáceæ.* |
| * Lapageria Family | *Philesiáceæ.* |

## Class III.—CORMOGENS.

**Filicales.**

| | |
|---|---|
| Fern Family | *Filices.* |

**Lycopodales.**

| | |
|---|---|
| Lycopodium Family | *Lycopodiáceæ.* |
| Pill-wort ,, | *Marsileáceæ.* |

**Muscales.**

| | |
|---|---|
| Moss Family | *Musci.* |
| Marchantia Family | *Marchantiáceæ.* |
| Horsetail ,, | *Equisetáceæ.* |

## Class IV.—THALLOGENS.

| | |
|---|---|
| Lichen Family | *Lichenes.* |
| Mushroom ,, | *Fungi.* |
| Chara Family | *Characeæ.* |
| Seaweed ,, | *Algæ.* |

## GENERA AND SPECIES.

"Genera" bear the same relation to families that the families do to the alliances and primary classes. Walk round a large garden, and you will see many kinds of lupine, and many kinds of potentilla. Similarly, in the fields, we find many kinds of buttercup, and many kinds of sedge. Each of these little companies, the lupines, the potentillas, the buttercups, the sedges, constitutes a "genus," and each of the constituent kinds is a "species." The "genera" are founded upon peculiarities in the flower and fruit, common to all the species which they include; the "species" are distinguished by differences in the form of the leaves and the inflorescence, and in the general habit and configuration of the plant. It is often observable also that species have their own particular habitats or places of growth, that their flowers have peculiar odours, and that they blossom at definite seasons, different from those of the other species of their genus. To a certain extent characters and preferences of this nature are observable likewise in genera; but in neither case do they constitute prime and diagnostic distinctions, which must always be such as dried specimens will show nearly as well as living ones: in other words, the essential characters of the genus and species depend alike upon the *structure* of the

plant, and on nothing else, though when the structure is eccentric and perplexing, the habitat, odour, etc., have great value as suggesting and corroborating the affinities of the plant, and when the proper characters have been ascertained, they become a useful supplement.

In some families the genera are very easily discriminated; in others they are distinguished with difficulty. As a rule, the easier it is to tell the family, the more are we puzzled with the genera, and *vice versâ*. Ferns, grasses, fungi, are told on the instant, and the youngest botanical learner has no doubt as to the family of a cruciferous plant, or of an umbelliferous one. But the *genera* of these families and of many others, are scarcely yet made out with certainty, and it is rare to find two botanists agreed about them; the fact being that genera, like families, may be rendered more or less extensive according to the mental constitution of the botanist who undertakes to determine the differences, some botanists being for very limited and rigid boundaries, others considering a comparatively wide deviation still compatible. Hence it is that the common shield-fern is by some called "Aspidium," by others "Nephrodium," by others, again, "Lastræa." Nothing, on the contrary, is more easy than to recognise an aconite, an anemone, a clematis, or a meadow-rue, each representing a genus; but there must be much study in order to see that these are all indubi-

table members of the Ranunculaceæ. To beginners, the characters of genera are almost always embarrassing. True, when once a species of any given genus is well known, all its immediate relatives are easily identified as such, even when seen for the first time, by the similarity of their habit and contour; since the external likeness is usually a readier guide than the strict technical or scientific character, and hence we very soon learn buttercups, heaths, roses, brambles, etc., by *sight.* But the *technical* character lies deeper. To determine this we have usually to wait for the ripe fruit, by which time the flowers are gone, and the foliage is often faded.

"Species," like genera, are more or less easily distinguishable according to circumstances, and, to a certain extent, they also resemble genera in being subject to the opinion of man. Some botanists combine many various aspects and configurations, as expressed in individuals, and say "these are all compatible with the idea of the species"; others take these various aspects as denoting essential differences of species. Principally from this cause, we find the number of species of British flowering-plants reckoned by Mr. Bentham as less than 1300, while Mr. Babington considers them to exceed 1700. With which opinion it is best to take sides every one must judge for himself, bearing in mind, however, as a first principle, that undue combination is always a less evil than excessive separation; and, on

the other hand, that what is called "union" may sometimes be only another name for confusion. Nothing will be saved on either side in labour, for the student must go through precisely the same careful series of observations to enable him to judge fairly whether things are alike or different. With those writers who prefer synthesis, or the lower estimates as to numbers, the cause of the seeming diversity lies in the influence of soil, climate, and other physical conditions and circumstances of growth, and the operation of these is unquestionably very powerful. But no one can yet say how far it modifies plants permanently, or to what extent Mr. Darwin's doctrines of "natural selection," and the gradual elaboration of all forms of vegetables from a single primæval form, are true, or likely to be true. It is easy to pick out differential features in plants; but the full idea of a species includes not merely technical characters, but all its relations and economy, no plant being rightly understood, any more than any animal, till it has been viewed, for a time, as the very centre and pivot of nature. Plants undergo incredible changes of form almost while we watch them, and seem to delight in outstripping our wonder at their capacity for harlequinade. It is plain, moreover, that there is an homology in plants, just as there is in animals, and that what many call "differences," and think absolute, are to an enlarged and philosophical apprehension, merely varied utter-

ances of the same general statement,—the melody played an octave higher or an octave lower,—the same thought expressed in another dialect, palpably enough to the linguist; and that accidents and gardeners undermine all definitions, however carefully drawn up. On the other hand, there are magnificent principles of nature which at once prepare us for all this waywardness, and reconcile us to all this mystery, and that seem to point to an original multiplicity of species as one of the prime characters of creation, the present occupants of the soil occupying our planet as the last of many successive dynasties that have followed one another during the lapse of ages,—not, however, as the result simply of monotonous physical causes, to which the origins of things can never be ultimately referred, but as the result of profounder ones, lying far back, and operating from the invisible world in which all nature has its beginning and permanency.* These principles bring with them the consoling conviction that some part, at least, of what we see around us is fixed and immutable, and that Botany has something more to deal with than vague and extinguishable phenomena. In any case, for the purposes of practical Botany, plants in their great mass are permanent in form, and plainly enough distinguishable. There are over 1200 forms in Great Britain which are as distinct

* See the author's "Life, its Nature," etc. pp. 127, 128, and 321. Ed. 2.

from one another as our brothers and cousins are, and which no one ever thinks of calling by any other name than that of "species." The white water-lily and the yellow water-lily, the sweet violet and the marsh violet, are subjects of no dispute:— in the permanency of these there is perennial delight, as in the sportiveness of the ferns an ever-recurring astonishment.

## VARIETIES.

"Varieties" are those deviations from the wild specific type, induced by accidents of soil and situation, and more particularly by cultivation, which adorn our gardens with the countless forms presented by the dahlia, the pansy, the hyacinth, and the majority of "florists' flowers." Varieties also occur, though not so frequently, among plants living in a state of nature. It is over these latter that there is so much conflict of opinion, as when the sixty or seventy expressions of the common bramble are published as so many "species." When the difference lies merely in the colour of the flower, which often happens, or in its conversion into the "double" condition, though the amount of change differs only in degree, it is considered unimportant. A large class of varieties among wild plants comprehends those induced by growth in water. The leaves of plants which on the edges of a pond or stream are broad and flat, often, when wholly sub-

merged, and especially if subjected to a current, lengthen into long, green, hair-like fibres, that remind us of some seaweeds. No rule can be laid down for discriminating at all times between the normal or original form of a plant and the varieties it may run into. Large experience can alone even approximate this power. The best that can be said perhaps is that the "variety" seldom repeats itself through its seeds, but relapses into the original form, or changes to another variety. But it always keeps true to the species it belongs to. The dahlia is still a dahlia, whatever its hue, and whether it be a "globe" or a "quilled."

## HYBRIDS.

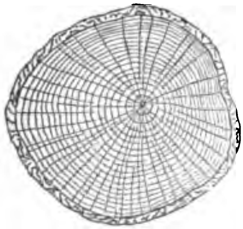
"Hybrids" are vegetable mules,—that is to say, intermediate forms obtained by applying the pollen of one species or variety to the stigma of a different one. Gardeners now raise great numbers of hybrids, both among culinary vegetables and ornamental flowers. Such plants of course cannot inherit the name of either parent, and their origin is generally expressed in a special appellation. Hybrids are pro-probably very rare in wild nature. Although the bees carry pollen casually from one species of plant to another, the integrity of each appears to be preserved by its peculiar economy. The differences in the pollen-grains and in the organization of the stigma serve, probably, as a physical hindrance, but

lying underneath there is no doubt a chaste antipathy, too exquisite for eyes that contemplate only the anatomy of the parts; there nevertheless, preserving the lily immaculate, and the snowdrop not more pure in petals than in life.

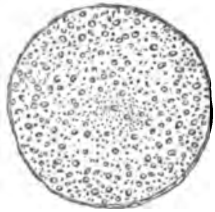
## THE NAMES OF PLANTS.

A few words may be said in conclusion upon the *names* applied to plants. These are either vernacular or "botanical." The vernacular name is that by which a plant is commonly called in the country or district where it grows wild or is ordinarily cultivated; the "botanical" is that by which it is known to science, and is either directly derived from the Latin or Greek language, or has had a Latin form and termination given to it, at once for the sake of uniformity, and to adapt it for citation either in Latin writings or in foreign languages. The Latin names have in no case been given out of pedantry; they are absolutely necessary to men of science, who cannot possibly communicate accurately without using them. Both sets of names have in many cases an "alias." The vernacular names differ in almost every part of the country,—just as the daisy, which in France is called the "marguerite," is in Scotland termed "gowans"; the botanical names similarly differ in various authors, owing principally to individual and usually improved views as to the affinities of plants. But there is a great

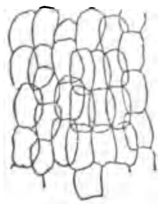
deal of mere caprice in this matter, and a large portion of the synonyms with which books are unhappily crowded would have been better never contrived. Properly constructed, both the vernacular and the botanical names are twofold, one denoting the genus and the other the species. Thus, LATHYRUS *latifolius*, the "broad-leaved pea"; LATHYRUS *odoratus*, the "sweet-scented pea"; LATHYRUS *azureus*, the "blue-flowered pea." LATHYRUS and "pea" are here the "generic" names, and the adjectives are the "specific." In some instances, vernacular names are simple, as primrose, cowslip, daffodil, and turnip; but it is seldom that a precise idea is conveyed by such, any more than by the use of a man's surname without the "Christian." The particular derivations or etymologies of the various names, both vernacular and botanical, have to be sought in many directions. They form an immense and very delightful object of investigation, being in many cases extremely ancient, and often highly figurative and poetical. Many others are commemorative, or given in honour of eminent botanists, whose example is thus pleasantly held up before the mind when the plant happens to come in view. Such are the generic names *Linnæa*, *Banksia*, and *Caleya*, and the specific names *Köhleri*, *Œderi*, and *Hookeri*.



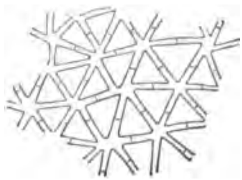
1. Stem of Exogen, horizontal section.



2. Stem of Endogen, horizontal section.



3. Cellular Tissue, highly magnified.



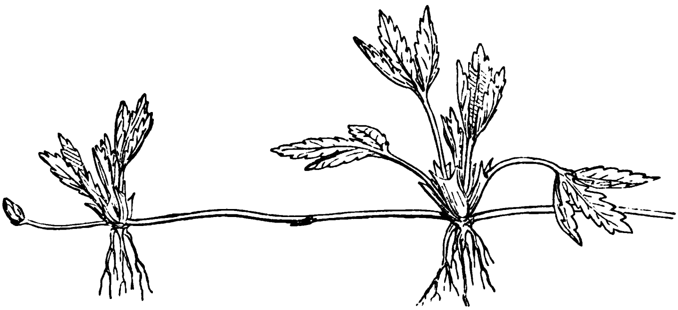
4. Pith of Rush, highly magnified.

5. Bulb of Hyacinth.

6. Bulb of Hyacinth, vertical section.

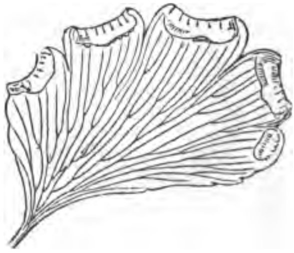
7. Tubers of Potato.

8. Tubers of Orchis.

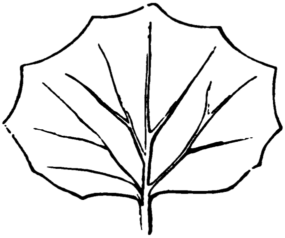


9. Creeping Stem.

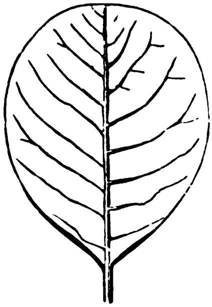
10. Stomates of Leaf, highly magnified.



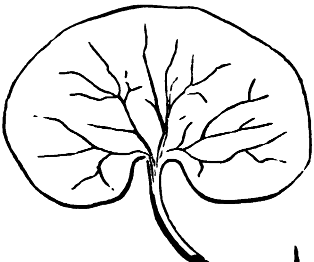
11. Maiden-hair Fern.



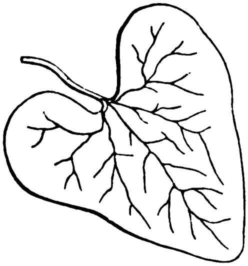
12. Waved Leaf.



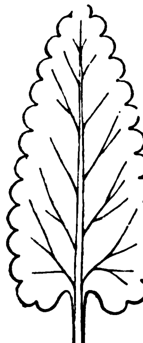
13. Leaf of Rhus Cotinus.



14. Leaf of Asarum.

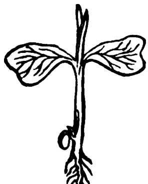


15. Cordate Leaf.

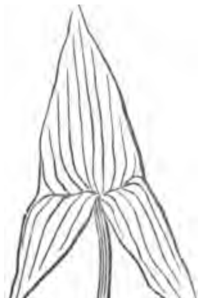


16. Leaf of Betony.

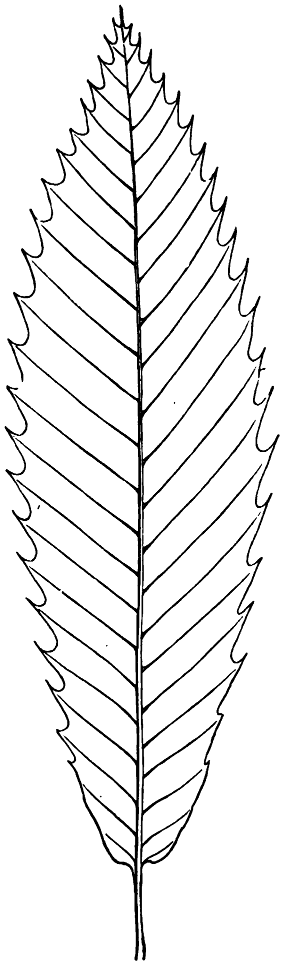
17. Germinating Endogen.



18. Germinating Exogen.



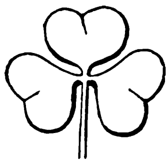
19. Arrow-shaped Leaf.



20. Leaf of Spanish Chestnut.

21. Acuminate Leaf.

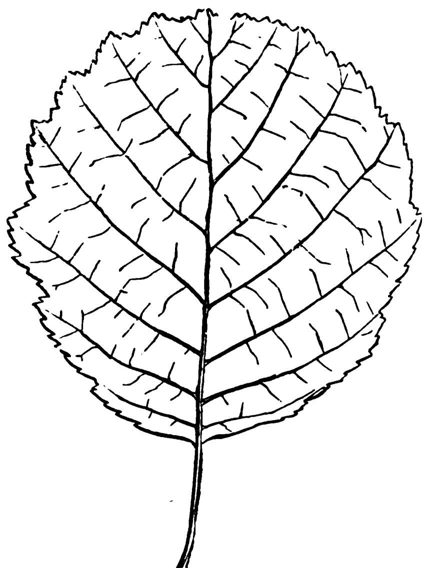
22. Ovate Leaf.



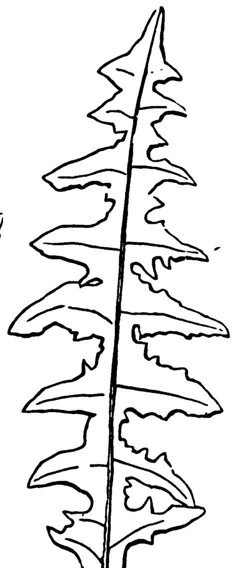
23. Ternate Leaf.

24. Leaf of Passion-flower.

25. Leaf of Lady's Mantle.



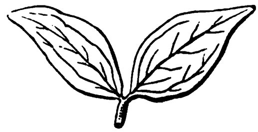
26. Leaf of Alder-tree.



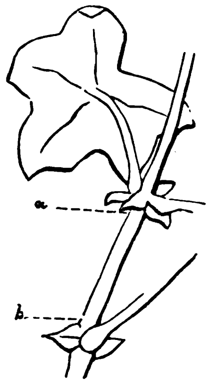
27. Leaf of Dandelion.

28. Leaf and Stipules of Tormentil.

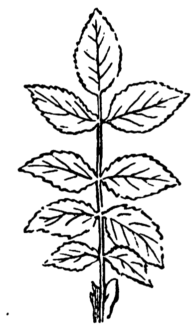
29. Leaf of Silverweed.



30. Binate Leaf.

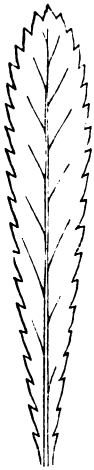



31. Internodes of Geranium Stem.



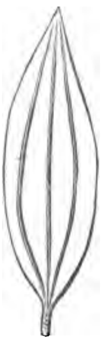
32. Leaf of Rose-bush.

33. Doubly-pinnate Leaf.



34. Serrate Leaf.

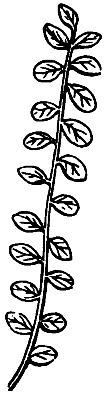
35. Lanceolate Leaf.



36. Ribbed Leaf.

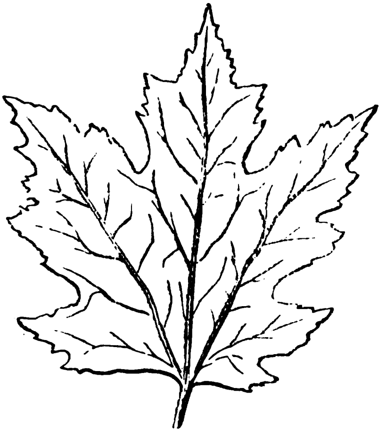
37. Leaf of Convolvulus.

38. Leaf of Pavia.

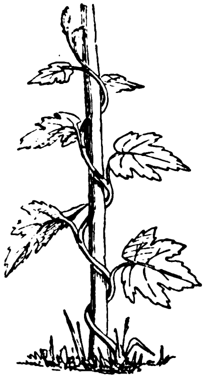


39. Pinnate Leaf.

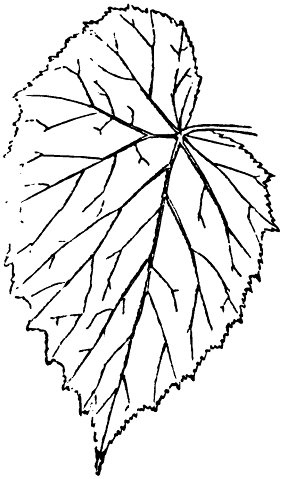
40. Leaf of Monkshood.



41 Leaf of Maple.

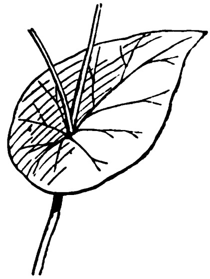


42. Twining Stem.

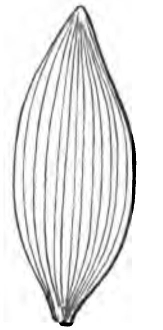


43 Leaf of Begonia.

44. Pinnatifid Leaf.

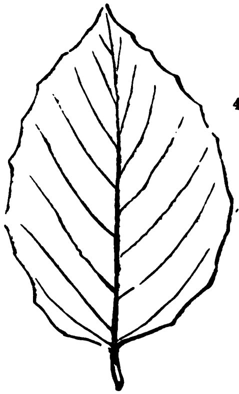


**45.** Perfoliate Stem.



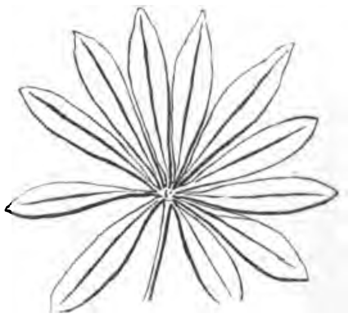
**46.** Curvinerved Leaf.

**47.** Linear Leaf.



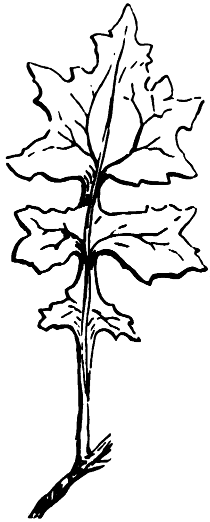
**48.** Leaf of Beech-tree.

**49.** Leaf of Elm-tree.

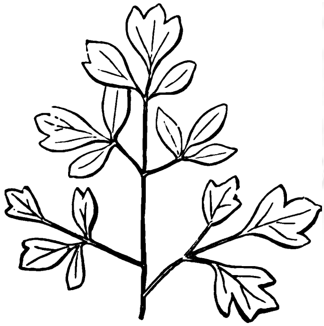


**50.** Leaf of Lupine.

51. Ivy.



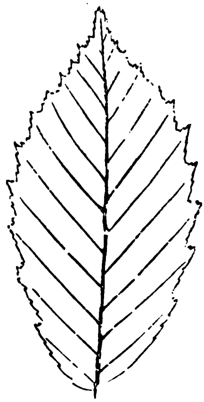
52. Leaf of Prenanthes.



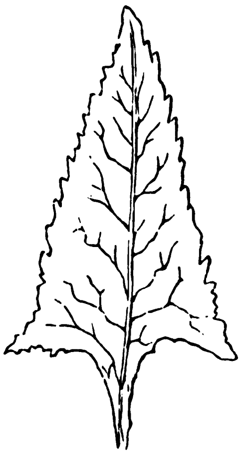
53. Leaf of Meadow-rue.

54. Leaf and Tendril of Vetch.

55. Spray of Oak Leaves.



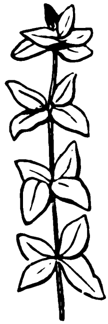
56. Doubly-serrate Leaf.



57. Triangular Leaf.

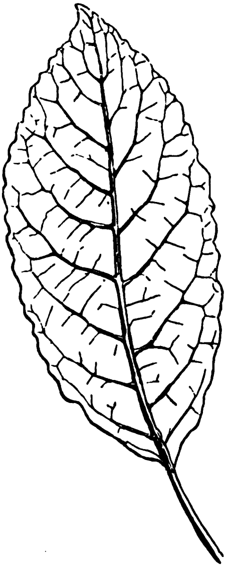
58. Leaf of Hasel-nut.

59. Prickles of Rose.

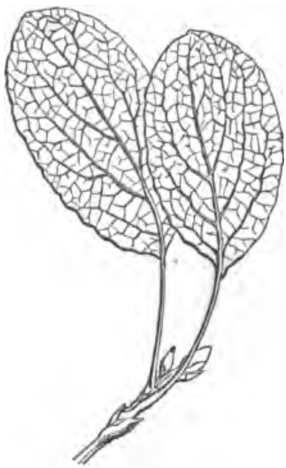


60. Leaves of Cross-wort.

61. Leaf of Begonia.



62. Leaf of Sallow.



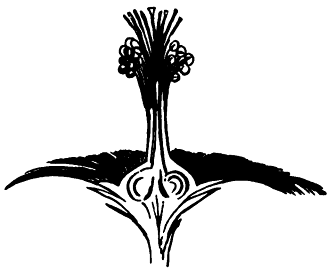
63. Leaves of Dwarf Willow.

65. Alternate Leaves.

64. Leaf of Bramble.

66. Capsule of Pimpernel.

67. Flower of Mallow.



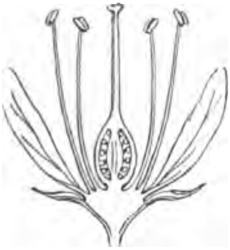
68. Flower of Mallow, vertical section.

**69. Tetradynamous Stamens.**

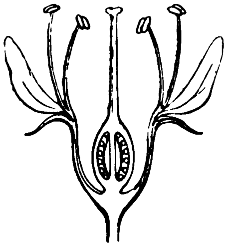
**70. Flower of Foxglove, laid open.**

**71. Stamen.**

**72. Pistil.**



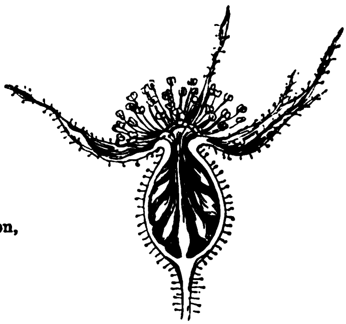
**73. Hypogynous Stamens.**



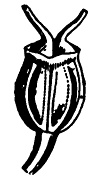
**74. Perigynous Stamens.**

**75. Epigynous Stamens.**

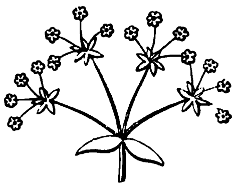
**76. Flower of Mezereon, laid open.**



**77. Vertical Section of Rose, the petals removed.**

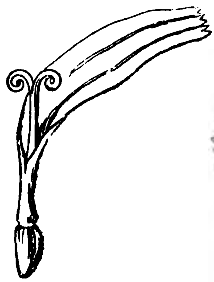


**78. Unripe Cremocarp.**



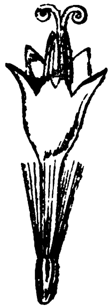
79. Compound Umbel.

80. Flower of Pea.



81. Ligulate Floret.

82. Compound Flower.



83. Tubular Floret, enlarged.

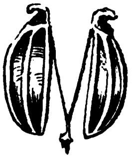
84. Compound Flower.

85. Underside of Rose.

86. Legume.

87. Capsule of Poppy.

88. Siliques of Virginian Stock.

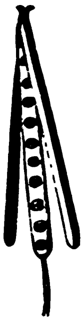


89. Ripe Cremocarp.

90. Ripe Follicles of Larkspur.

91. Ripe Capsule oı Lily.

92. Bird's-foot.



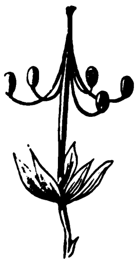
93. Ripe Silique.

94. Ripe Capsule of Meconopsis.

95. Diadelphous Stamens.

96. Raspberry.

97. Flower of Monkshood.



98. Ripe Fruit of Geranium.

99. Toothwort.

100. Primrose.

101. Victoria Regia.

102. Passion-flower.

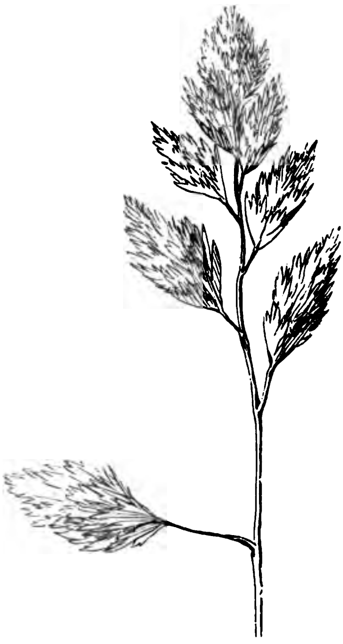
103. Japan Lily.

104. Cuphea.

105. Flower-spike of Grass.

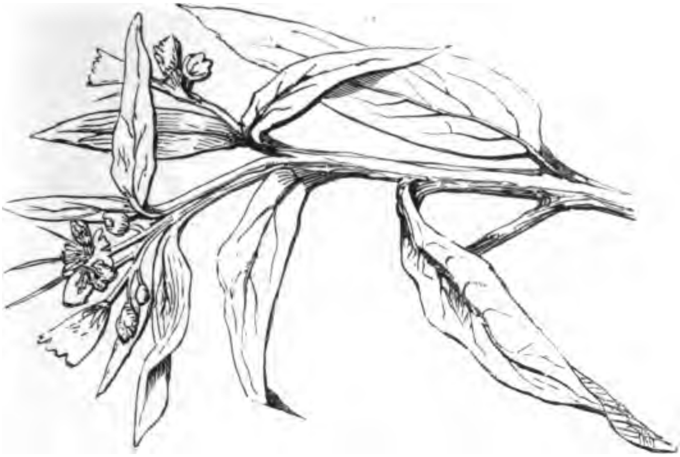
106. Woodruff.

107. Sweet William.



108. Cock's-foot Grass.


109. Ground-ivy.


110. Comfrey.

111. Diadelphous Stamens.

112. Cerbera.

113. Brome Grass.

114. Belladonna.

115. Convolvulus.

116. Caper Spurge.

117. Banana.

118. Sweet-scented Vernal-grass.

1!9. Tormentil.

120. Chlora.

121. Narcissus.

122. Calyx, Corolla, and Stamens.

123. Osmunda.

124. Sea Poppy.

125. Parnassia.

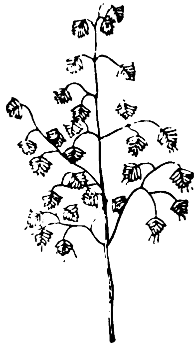
126. Celandine.

127. Reindeer Lichen.

128. Narcissus.

129. Trimerous Flower.

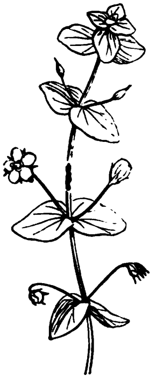
130. Periwinkle.



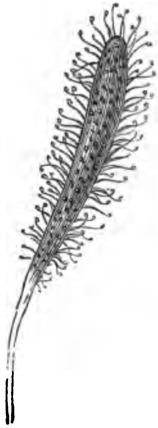
131. Quaking Grass.

132. Gloxinia.

133. Heather.



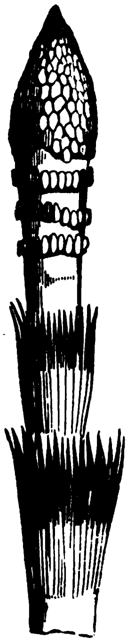
135. Labiate corolla.



134. Pimpernel. 136. Corolla of Speedwell. 137. Leaf of Sundew.

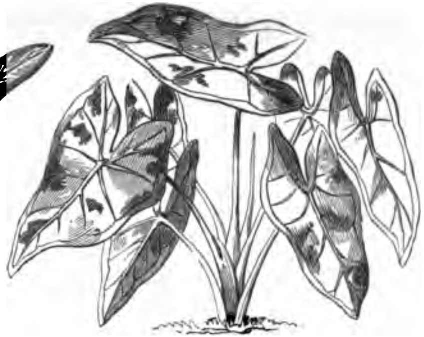
138. Hard-heads.

139. Stachys.



140. Equisetum.

141. Leaf of Caladium.



142. Caladium.

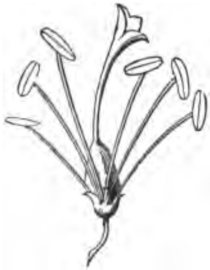
143. Leaf of Anthurium.

144. Catkin of Birch-tree.

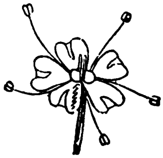
145. Rosaceous Flower.

146. Pentamerous Flower.

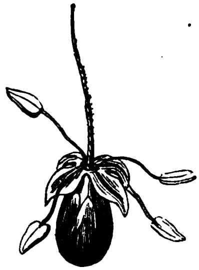
147. Moss.



148. Stamens and Pistil.



149.
Flower of Hemlock.



150. Flower of Plantago, enlarged.

151. Peziza.

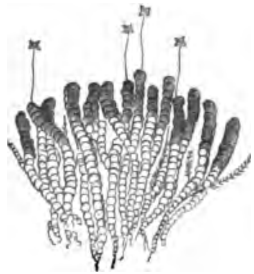
152. Pentamerous Flower.

153. Flower of Grass.

154. Umbel of Wild Garlic.

155. Male Catkins of Sallow.

156. Liverwort.



157. Jungermannia.

158. Pinnules of Shield-fern.

159. Galium.

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# LIST OF WORKS

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